

DATA REPORT

**SATELLITE-TRACKED SURFACE-LAYER
DRIFTERS RELEASED
AT THE 106-MILE SITE**

Submitted to

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Prepared by

Paul Dragos

**Battelle Ocean Sciences
397 Washington Street
Duxbury, MA 02332
(617) 934-0571**

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1.0 INTRODUCTION

This data report presents a summary of results for the satellite-tracked surface-layer drifting buoy program at the 106-Mile Deepwater Municipal Sludge Dump Site (106-Mile Site). Between October 1989 and June 1991, 66 drifters were released in the 106-Mile Site and subsequently tracked by Service Argos satellites for four months each. The drifters consisted of a surface buoy attached to a drogue centered at 10 m depth to closely follow the movement of water within the surface mixed layer — the well-mixed near-surface water above the density interface or pycnocline. The resulting trajectories of water-mass transport provide an indication of the farfield fate of fine sludge particles released at the 106-Mile Site.

The 106-Mile Site, located southeast of New York (Figure 1), is the only United States ocean disposal site designated for dumping of sewage sludge. Evaluation of sludge disposal and of the fate and effects of sludge dumped at the 106-Mile Site has been conducted since 1986 under a monitoring plan developed and implemented by the Environmental Protection Agency (EPA, 1991a,b). In 1988, the United States Congress passed the Ocean Dumping Ban Act (ODBA), under which EPA, the National Oceanic and Atmospheric Administration (NOAA), and the United States Coast Guard (USCG) jointly developed a new 106-Mile Site monitoring plan (EPA, 1990a). This interagency plan continues the monitoring and research activities of the EPA monitoring plan, which it supersedes. Tier 3 of the Joint Monitoring Plan addresses the transport and fate of sludge in the long term and the farfield. As part of Tier 3 studies, beginning under the EPA Monitoring Plan (EPA, 1991a,b) and continued under the Joint Monitoring Plan (EPA, 1990a), the satellite-track drifter program described in this report was developed. An interim data report including data from drifters deployed between October 1989 and December 1990 was prepared and submitted to EPA previously (EPA, 1991c).

The use of satellite-tracked drifters for ocean circulation studies has become increasingly common in the past few years due to the availability of relatively inexpensive drifters and a comprehensive tracking service (see, for instance, Richardson, 1981; Davis, 1985a,b; Krauss, 1987; Molinari, 1990; Thomson, 1990). The resulting position data (i.e., Lagrangian or particle-following trajectories) give direct insight into water-mass movement and provide visualization of the large-scale flow features. Lagrangian measurements address directly those features of the current field important to the horizontal transport of suspended particles. In addition to the qualitative description of the flow given by the trajectories, the large number of drifters released in this study results in a base of Lagrangian

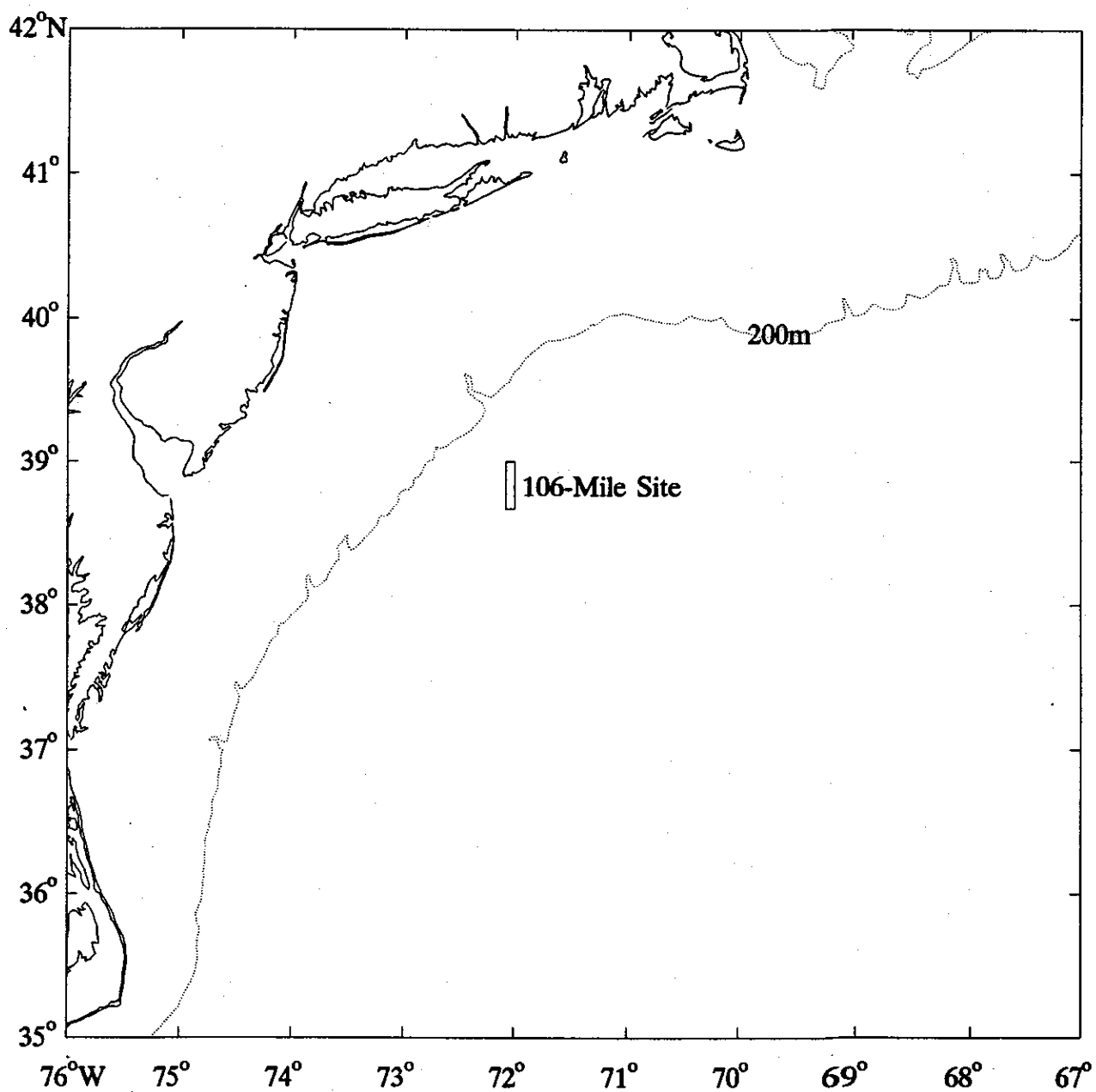


Figure 1. Map of Mid-Atlantic Bight showing location of the 106-Mile Site.

statistics that can be used to describe and quantify the nature of the near-surface flow from the 106-Mile Site including mean velocity, dispersion characteristics, exchange of slope water onto the Continental Shelf, and the potential stagnation or recirculation of plume water from the 106-Mile Site within the Slope Sea.

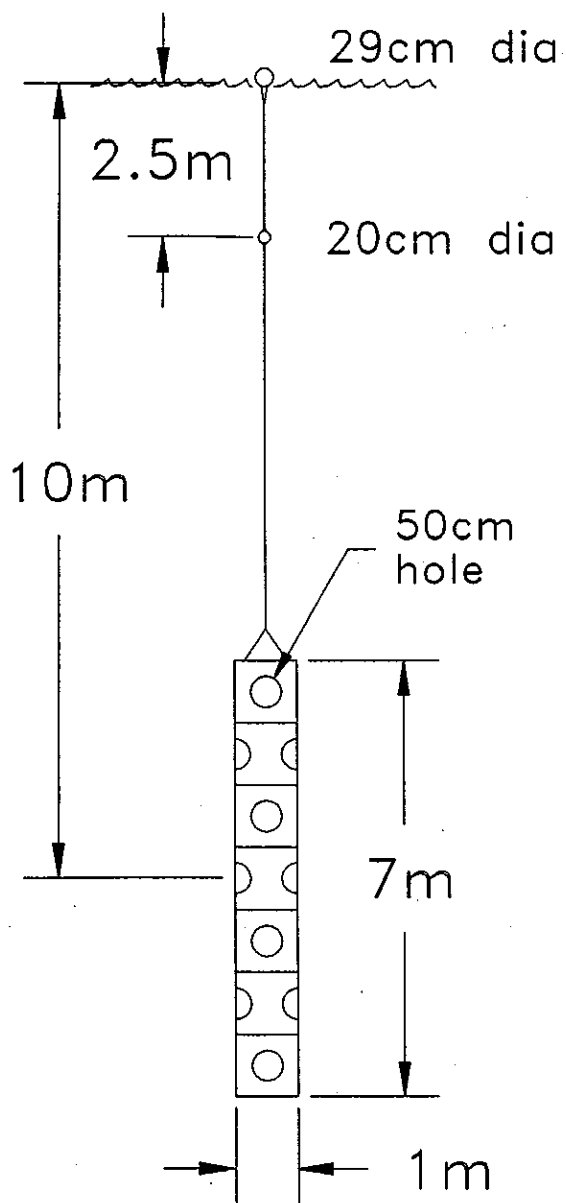
2.0 THE FIELD PROGRAM

2.1 Satellite-Tracked Lagrangian Drifters

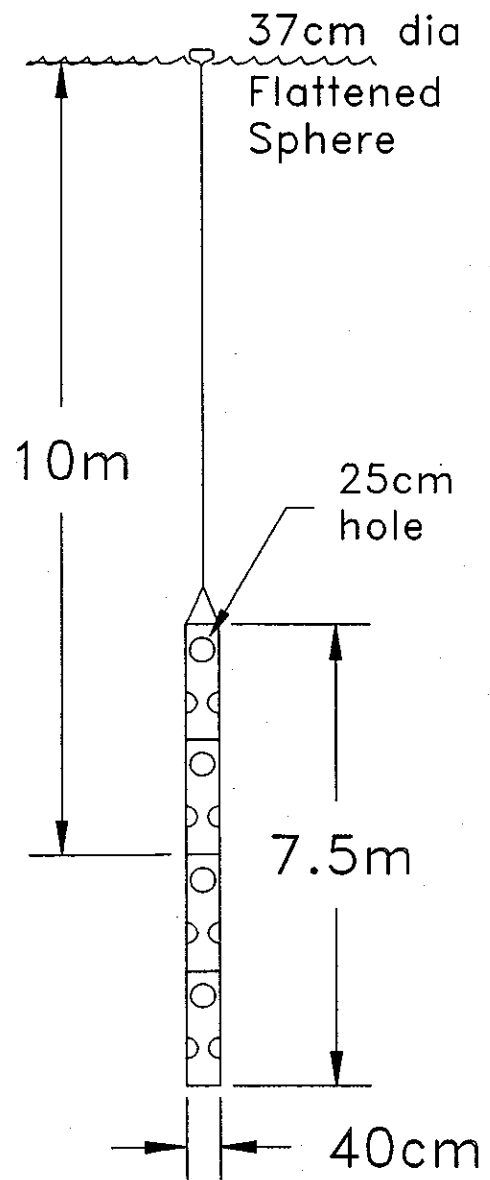
Between October 1989 and June 1991, 66 satellite-tracked drifters were released at the 106-Mile Site. Each was programmed to operate for 4 months. The drifters employed in this program were designed to be accurate current followers in the presence of wind and waves. Each consists of a small surface buoy and a large subsurface drogue (Figure 2). The surface buoy provides buoyancy and houses the satellite transmitter, antenna, batteries, sea-surface temperature sensor, and drogue presence indicator and is designed with a low profile to minimize windage. The drogue, suspended below the surface in the mixed layer, provides the large cross-sectional area needed to anchor the drifting buoy to the mixed-layer flow. Drogues of various configurations have been used in the past, but the so-called holey sock (or lamp-shade) drogue was chosen for this application. Holey sock drogues present the same cross-sectional area in any direction and generate a minimum of vertical drag during the heaving motions caused by surface waves. Field calibrations of holey sock drifters (Geyer, 1989) have shown an acceptably small slip velocity (the difference between the velocity of the drifter and that of the water surrounding the drogue). Figure 2 details the drifter configurations used at the 106-Mile Site.

Drifters manufactured by two different suppliers were used. The first 10 drifters [the so-called Low Cost Drifter (LCD)] were purchased directly by EPA from the Charles Stark Draper Laboratory, Inc. (Cambridge, Massachusetts). All subsequent drifters were purchased by the sludge dumping permittees (with EPA approval) from Clearwater Consultants (Newton, Massachusetts). The technical specifications for both drifters are given in Tables 1 and 2.

Satellite tracking of buoy positions was performed by Service Argos, a joint US/French Government program that provides position tracking and environmental data transmission anywhere on the surface of the earth (Service Argos, 1988). Service Argos is a cooperative program between Centre National



Clearwater Drifter



Draper Labs Drifter

Figure 2. Dimensional drifter schematic for satellite-tracked drifters used in the 106-Mile Site drifter program.

Table 1. Clearwater Consultants Holey Sock Drifter.

Component	Description
Surface float	29-cm-dia sphere, fiberglass surface float
Tether	5/32-in. wire rope, covered with stiff rubber hose from the surface to 25 cm below the subsurface float
Subsurface float	20-cm-dia sphere, plastic foam-filled subsurface float attached 2.5 m below the surface
Drogue	1-m-dia, 7-m-long holey sock of reinforced nylon cloth; drogue centered at 10 m depth; 50-cm-dia holes cut through nylon orthogonally placed on alternate 1-m vertical sections; 2.5-cm polyethylene pipe hoops sewn into each segment for support; 4.5-kg weight sewn into base of sock
Transmitter	Telonics transmitter (approved by Service Argos). Antenna mounted inside surface float. Duty cycle: transmission every 84-96 s. Endurance: 4 months. Power supply: alkaline battery pack
Antifouling	Antifouling coating on all subsurface components except wire tether and nylon drogue cloth
Sensors	Thermistor sensor imbedded in through-hull fitting at base of surface float. Drogue presence sensor (surface float submergence switch)

Table 2. Charles Stark Draper Laboratory, Inc., LCD Holey Sock Drifter.

Component	Description
Surface float	37-cm-dia flattened sphere, Lexan® surface float
Tether	Polypropylene rope with wire rope core
Drogue	0.4-m-dia, 7.5-m-long holey sock of reinforced nylon material; drogue centered at 10-m depth; 0.5-m holes cut through nylon orthogonally placed on alternate 50-cm vertical sections; polyethylene rod hoops sewn into each segment for support; steel ballast hoop sewn into base of sock
Transmitter	Telonics transmitter (approved by Service Argos). Antenna mounted inside surface float. Duty cycle: transmission every 90 s. Endurance: 4 months. Power supply: alkaline battery pack
Antifouling	Antifouling coating on all subsurface components except drogue nylon cloth
Sensors	Thermistor sensor cemented inside the surface float hull. Drogue presence sensor (drogue tether strain gauge)

d'Études Spatiales (CNES, the French Space Agency), the National Aeronautics and Space Administration (NASA), and NOAA.

Service Argos onboard packages are carried by two NOAA satellites in circular, polar orbit. These satellites orbit the earth every 102 min, or 14 times a day. They have a visibility area (i.e., footprint) with a 5000-km diameter on the surface of the earth over which they can receive signals from transmitters. Surface transmitters, the so-called user platforms, transmit radio frequency messages approximately every 90 s. These messages can contain short strings of sensor data as well as the necessary Service Argos protocols. Because satellite footprint overlap increases with latitude, the mean number of daily passes over a position is a function of latitude. There are about 26 passes each day over the 106-Mile Site. During a satellite pass, user platforms that are located near the center of the footprint will find the satellite overhead longer than those located at the periphery of the footprint, so that the number of buoy transmissions received by a satellite per pass varies from 1 to 10 at the 90-s update rate. The satellites calculate the straight-line distance to a transmitter from the Doppler shift in the transmitter frequency, and so must determine the location of the transmitters by triangulating from at least three separate fixes in a single pass. Hence, not all passes result in position fixes, although all passes do result in data transmission. For the Mid-Atlantic Bight and the 106-Mile Site, typically about eight location fixes are obtained per day, or a fix every 3 h for each transmitting buoy.

User platform data and locations are stored in the satellite until it passes over an earth receiving station, at which time the data are downloaded to Service Argos computers for processing, storage, and dissemination.

2.2 Deployment Summary

Drifter deployments began in October 1989, when four drifters were released from the EPA Ocean Survey Vessel, OSV *Anderson*, during a survey at the 106-Mile Site as part of EPA/OWOW Work Assignment 1-43. Another six drifters were deployed from late December 1989 through mid-March 1990 from the M/V *Oleander*, a ship-of-opportunity used regularly by NOAA for obtaining expendable bathythermograph profiles (XBT) over transects run from New York to Bermuda. Then, in late March 1990, the permittees began deploying drifters at approximately weekly intervals as part of the requirements for their ocean dumping permits. Each drifter contained battery power sufficient to transmit for at least 4 months, after which it was programmed to stop transmitting. (It was assumed

that the drifters would be well out of the area of interest by then.) Figure 3 shows the time lines, from deployment through last transmission, for all drifters. Sixty-six drifters were deployed during the 23-month duration of this program. A drifter was deployed on average every 8.3 days for the entire program, and every 7.8 days after the permittees began deployments in March 1990.

Drifter deployment is a simple operation that requires only switching the drifter on, paying out the drogue, and lowering the unit by hand over the side of the vessel. At the time of each deployment, a deployment log form (Figure 4) was completed by the personnel conducting the deployment, and a copy of the completed form was transmitted to Battelle upon return to shore. The deployment time and position reported on the log forms are checked against the first satellite position reported after the release. Each drifter's first satellite-reported position (which may be several hours after the deployment) is used as the deployment position for data-processing purposes to maintain consistent instrument accuracy; each is listed in Table 3 and shown in Figure 5.

2.3 Data Processing

Drifter position, water temperature, and diagnostic data were acquired from Service Argos computer storage via two avenues: (1) telephone modem to directly access the most recent 3 days of data stored on line at Service Argos and (2) monthly diskette copies distributed by Service Argos from off-line storage. Unfortunately, Service Argos does not provide on-line access downloading with error-checking protocols, and, consequently, data files retrieved on line often contained errors caused by noisy telephone lines. It was therefore decided that dialup data be used only to check current status of deployed drifters, i.e., scanning for drifters with lost drogues, bad transmitters, or drifters recovered by fishing boats. All data processing beyond status checking was performed on data received monthly on diskette from Service Argos.

When a monthly diskette was received, each drifter data file was extracted from the new data diskette and concatenated to previous files. When a drifter stopped transmitting at the end of 4 months (or earlier in the case of a drifter failure), the raw data file for that drifter was complete and the raw data were ready for quality assurance review and processing. First, the raw data files from diskette were reformatted into ASCII flat files. Recall that the satellites may receive several data channel

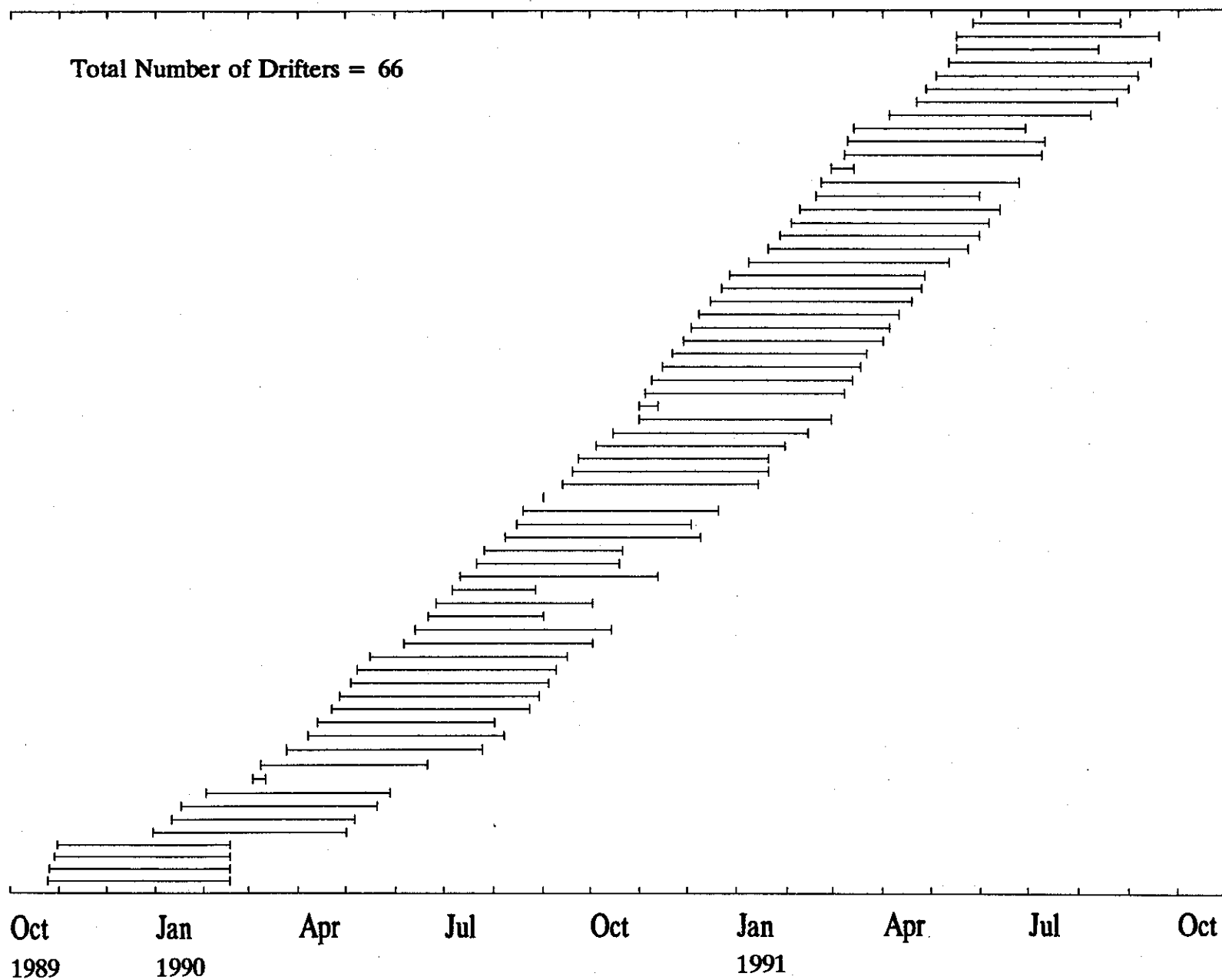


Figure 3. Drifter time lines for all drifters deployed at the 106-Mile Site.

DRIFTER DEPLOYMENT LOG

Name of Transport Company: _____

Name of Towing Vessel: _____

Name of Person Completing This Form: _____

Name of Barge: _____

Name of Person Deploying Drifter: _____

Port of Departure: _____

Time: _____

Date: _____

DRIFTER INFORMATION

Drifter Manufacturer: _____

Drifter Serial Number: _____

Drogue Depth: _____ m

Position of Launch:

_____ N Lat Loran TDs _____

_____ W Long _____

Time of Launch: _____

Date of Launch: _____

Weather:

Wave Height: _____ ft

Wind Speed: _____ kn

Wind Direction: _____ Deg

Figure 4. Drifter deployment log form.

Table 3. Drifter Deployment Summary.

Drifter Number	Deployment Date	Deployment Location ^a	
		Latitude (N)	Longitude (W)
9320	10-25-89	38°45.60'	72°01.26'
9321	10-26-89	38°54.96'	72°03.24'
9322	10-29-89	38°49.20'	72°03.90'
9323	10-31-89	38°53.28'	72°02.58'
9324	01-11-90	38°58.92'	72°00.18'
9325	12-30-89	38°55.80'	72°02.70'
9326	01-17-90	38°52.20'	72°00.24'
9327	02-02-90	38°59.58'	72°04.92'
9328	03-03-90	38°58.80'	72°04.02'
9329	03-08-90	38°35.04'	72°05.70'
12730	04-13-90	38°41.82'	72°00.66'
12731	03-24-90	38°47.10'	72°05.46'
12732	04-22-90	38°54.54'	72°03.72'
12733	04-27-90	38°40.50'	72°01.86'
12734	04-07-90	38°42.90'	72°04.80'
12735	05-08-90	38°41.10'	72°03.60'
12736	05-16-90	38°45.72'	72°01.98'
12737	06-06-90	38°43.68'	72°04.26'
12738	05-04-90	38°40.62'	72°02.88'
12739	06-26-90	38°48.12'	72°00.90'
12740	06-13-90	38°56.88'	72°00.18'
12741	06-21-90	38°40.08'	72°04.50'
12742	07-06-90	38°46.44'	72°00.48'
12743	10-31-90	38°59.64'	72°04.92'
12744	08-19-90	38°59.10'	72°01.74'
12745	07-21-90	38°41.40'	72°03.72'
12746	09-19-90	38°59.58'	72°03.00'
12747	08-08-90	38°56.88'	72°01.56'
12748	07-26-90	38°47.28'	72°00.90'
12749	07-11-90	38°47.16'	72°02.58'
12750	09-13-90	38°56.58'	72°02.28'
12751	08-15-90	38°54.12'	72°02.22'
12752	10-04-90	38°55.14'	72°01.80'
12753	10-15-90	38°40.44'	72°03.06'
12754	09-23-90	38°42.24'	72°02.76'
12755	10-31-90	38°59.64'	72°03.36'
12756	09-01-90	38°40.96'	72°03.17'
12757	11-21-90	38°57.78'	72°01.50'
12758	11-15-90	38°59.82'	72°01.20'
12759	11-28-90	38°56.88'	72°05.82'

Table 3. Drifter Deployment Summary (continued).

Drifter Number	Deployment Date	Deployment Location ^a	
		Latitude (N)	Longitude (W)
12760	12-15-90	38°42.48'	72°01.80'
12761	12-03-90	38°40.80'	72°01.08'
12762	12-08-90	38°59.64'	72°02.04'
12763	11-04-90	38°56.58'	72°02.94'
12764	01-08-91	38°51.72'	71°54.60'
12765	12-22-90	39°00.72'	72°03.18'
12766	02-08-91	38°52.14'	72°01.98'
12767	03-13-91	38°41.88'	72°03.42'
12768	11-08-90	38°59.04'	72°00.84'
12769	01-20-91	38°40.26'	72°03.84'
12770	12-27-90	38°56.70'	72°01.74'
12771	02-03-91	38°59.16'	72°03.78'
12772	03-09-91	38°39.66'	72°01.98'
12773	03-07-91	38°43.74'	72°01.74'
12774	02-18-91	38°41.58'	72°01.80'
12775	02-27-91	38°41.94'	72°02.40'
12776	01-27-91	38°59.52'	72°03.06'
12777	02-21-91	38°58.50'	72°02.64'
12730A	04-04-91	38°40.68'	71°59.16'
12731A	05-16-91	38°59.82'	72°04.38'
12732A	04-21-91	38°48.48'	72°19.32'
12733A	04-27-91	38°39.78'	72°04.02'
12734A	05-03-91	38°39.96'	72°03.78'
12735A	05-11-91	38°40.68'	72°05.70'
12736A	05-16-91	38°39.36'	72°06.00'
12737A	05-26-91	38°33.12'	71°55.44'

^aBased upon first satellite-derived position.

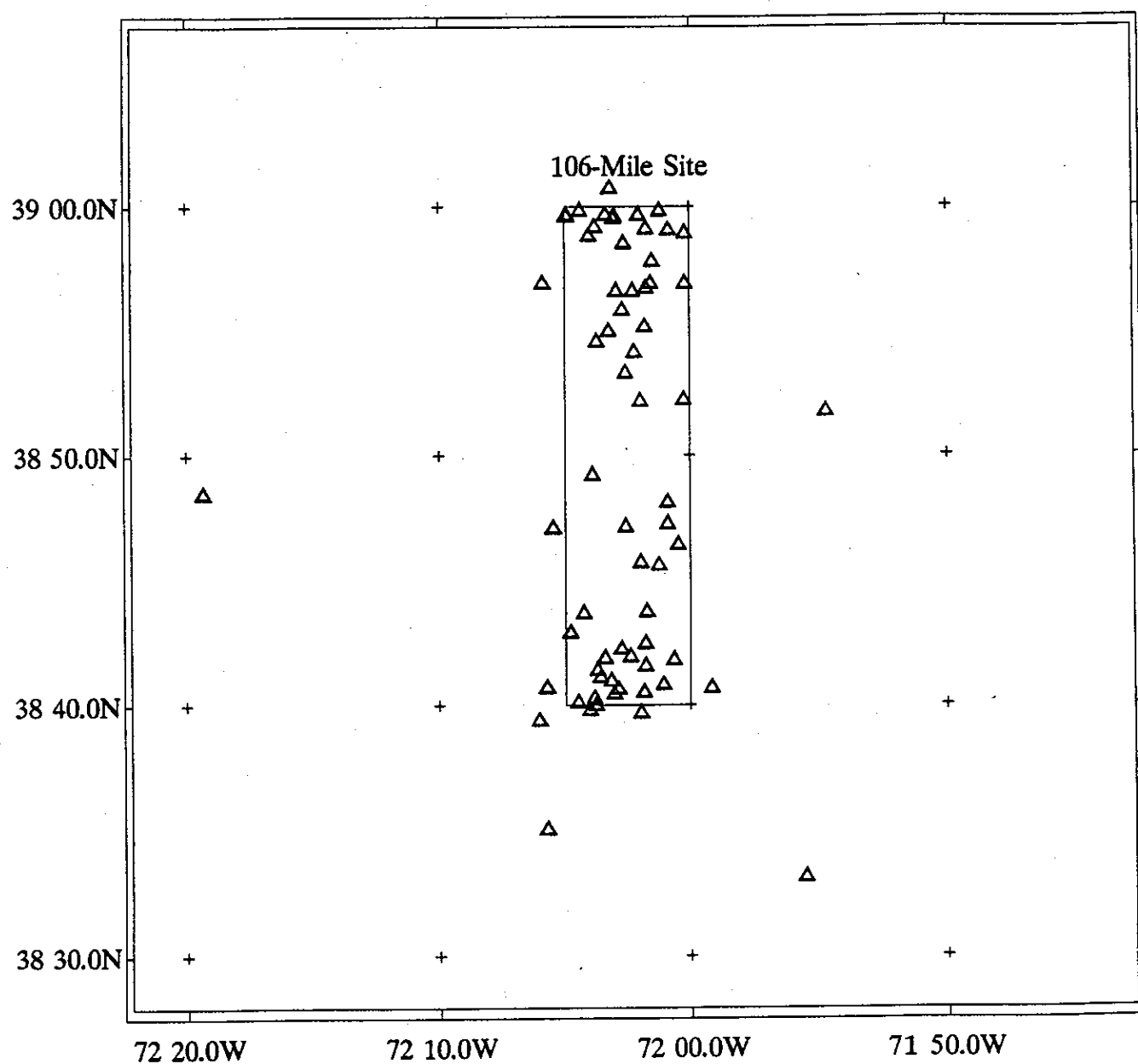


Figure 5. Drifter deployment positions based upon first satellite-derived position for **all** drifters deployed at the 106-Mile Site.

transmissions (temperature, battery, and drogue status data) for each position fix. The data channel parameters were converted to engineering units using algorithms provided by the drifter manufacturer and averaged for each position fix. Their variances were calculated to serve as an error indicator — nonzero variance in a data channel would indicate reception of different values during the same satellite pass. The resulting ASCII flat file contains date, time, position, position quality (determined by Service Argos), transmitted data, and data-channel error indicators.

Next, the ASCII flat files of raw drifter data were loaded into the drifter analysis and display software package developed at Battelle. Using this software package, the data were checked for quality per procedures detailed in the Work Plan for Work Assignment 2-41 (EPA, 1990b). Bad transmissions, wild points, and outliers were removed during the quality assurance editing procedure, and clean data files were generated for further analysis and distribution.

3.0 RESULTS AND DISCUSSION

3.1 Data Return

The data return for all drifter records are summarized in Table 4. Of the 66 drifters, one (12755) was picked up by a fishing vessel and lost and one (12756) stop transmitting immediately before deployment. The mean endurance of the remaining 64 drifters was 112 days. 84% transmitted for greater than 100 days. Additionally, four drifters (12730, 12747, 12757, and 12777) lost their drogues, and two more (9328 and 12775) transmitted for less than two weeks, leaving 58 drifters with usable, relatively long, data records. It should be noted that the experience of other investigators using satellite-tracked drifters has shown that when drifters reporting lost drogues are recovered, they sometimes still have their drogues attached (Richardson, 1981). The strain gauges or salt water switches used to report drogue status probably fail occasionally and report the drogue lost when it is not. However, this cannot be determined without recovering the drifter, and under the circumstances the data were not used. Some of the Clearwater drifters reported their drogues lost upon deployment, then after a few weeks, began reporting drogues present. Other investigators have observed this same

Table 4. Drifter Data Summary.

Drifter No.	Data Quality	Deployment Date	Last Transmission	Number Full Days	Drogue Status	Notes
09320		10-25-89	02-17-90	114	good	
09321		10-26-89	02-17-90	113	good	
09322		10-29-89	02-17-90	111	good	
09323		10-31-89	02-17-90	109	good	
09324		01-11-90	05-06-90	115	good	
09325		12-30-89	05-01-90	122	unknown	drogue sensor erratic, drogue probably present
09326		01-17-90	05-20-90	122	unknown	drogue sensor erratic, drogue probably present
09327		02-02-90	05-28-90	115	good	
09328	N/G	03-03-90	03-11-90	7	good	short record, transmitter malfunction
09329		03-08-90	06-20-90	104	good	
12730	N/G	04-13-90	08-01-90	109	N/G	drogue lost
12731		03-24-90	07-24-90	122	good	
12732		04-22-90	08-23-90	123	good	
12733		04-27-90	08-29-90	123	good	
12734		04-07-90	08-07-90	122	good	
12735		05-08-90	09-09-90	123	good	
12736		05-16-90	09-16-90	123	good	
12737		06-06-90	10-02-90	117	good	
12738		05-04-90	09-04-90	123	good	
12739		06-26-90	10-02-90	97	good	
12740		06-13-90	10-14-90	123	good	
12741		06-21-90	09-01-90	72	good	
12742		07-06-90	08-27-90	51	good	
12743		10-31-90	02-27-91	118	good	
12744		08-19-90	12-20-90	122	good	
12745		07-21-90	10-19-90	90	good	
12746		09-19-90	01-20-91	123	good	

Table 4. Drifter Data Summary (continued).

Drifter No.	Data Quality	Deployment Date	Last Transmission	Number Full Days	Drogue Status	Notes
12747	N/G	08-08-90	12-09-90	123	N/G	drogue lost
12748		07-26-90	10-21-90	87	good	
12749		07-11-90	11-12-90	123	good	temperature sensor malfunction
12750		09-13-90	01-14-91	122	good	
12751		08-15-90	12-03-90	109	good	
12752		10-04-90	01-30-91	117	good	
12753		10-15-90	02-13-91	120	good	
12754		09-23-90	01-20-91	119	good	temperature sensor malfunction
12755	N/G	10-31-90	11-12-91	11	unknown	recovered by fishing boat
12756	N/G					transmitter malfunction before deployment
12757	N/G	11-21-90	03-21-91	120	N/G	drogue lost
12758		11-15-90	03-17-91	122	good	
12759		11-28-90	03-31-91	123	good	
12760		12-15-90	04-18-91	123	good	
12761		12-03-90	04-04-91	122	good	
12762		12-08-90	04-10-91	123	good	
12763		11-04-90	03-07-91	122	good	
12764		01-08-91	05-11-91	123	good	
12765		12-22-90	04-24-91	123	good	temperature sensor malfunction
12766		02-08-91	06-12-91	123	good	
12767		03-13-91	06-28-91	106	good	
12768		11-08-90	03-12-91	123	good	
12769		01-20-91	05-23-91	122	good	
12770		12-27-90	04-26-91	119	good	
12771		02-03-91	06-05-91	122	good	
12772		03-09-91	07-10-91	123	good	
12773		03-07-91	07-08-91	122	good	

Table 4. Drifter Data Summary (continued).

Drifter No.	Data Quality	Deployment Date	Last Transmission	Number Full Days	Drogue Status	Notes
12774		02-18-91	05-30-91	100	good	
12775	N/G	02-27-91	03-13-91	14	good	short record, transmitter malfunction
12776		01-27-91	05-30-91	123	good	
12777	N/G	02-21-91	06-24-91	122	N/G	drogue lost
12730A		04-04-91	08-07-91	124	good	partial temperature sensor malfunction
12731A		05-16-91	08-12-91	87	good	recovered by fishing boat, redeployed
12732A		04-21-91	08-23-91	124	good	temperature sensor malfunction
12733A		04-27-91	08-30-91	124	good	
12734A		05-03-91	09-05-91	124	good	partial temperature sensor malfunction
12735A		05-11-91	09-13-91	124	unknown	drogue sensor erratic, drogue probably present, temperature sensor malfunction
12736A		05-16-91	09-18-91	124	good	
12737A		05-26-91	08-25-91	91	good	

N/G: No good.

discrepancy on drifters that, like the Clearwater drifters, employ a salt water switch to measure drogue status, and attributed it to a small amount of oil or grease on the switch which eventually washes off. With that assumption, data from these drifters have been included in this data set. Based upon these criteria there were 6680 good drifter days (providing usable data) out of a possible 7920 drifter days for a total data return of 84%.

3.2 General Features of Circulation

The complete set of drifter tracks for all 58 drifter records are overlain in Figures 6. This summary plot shows the area covered by the 4-month drifter records. Although individual trajectories are difficult to follow because of overlapping, some general features stand out. The mean slope-sea circulation carries the drifters generally southwest from the Site until they reach the north wall of the Gulf Stream. Once entrained in the Gulf Stream flow, they move rapidly eastward, following the meanders and eddies of the Stream as it carries them out into the Mid-North Atlantic. None move significantly onto the Continental Shelf and none are seen to cross the Gulf Stream west of 50°W longitude.

Figure 7 is an enlargement of the Mid-Atlantic Bight area, showing all 58 drifter trajectories overlaid as before. In this Figure, the common trajectory structure is more evident. After deployment at the 106-Mile Site, drifters move southwestward, entrained in the mean slope-sea current traveling along local isobaths until they reach the Gulf Stream between 36° N and 37.5° N latitude. [This can also be seen later in Figures 9(a)-(d).] Most drifters, but not all, exit the 106-Mile Site toward the southwest after deployment, but even those that exit northward (because of some local flow anomalies) soon become entrained in the mean southwestward current. (See the appendix to this report and the appendix to the interim Data Report (EPA, 1991c) for individual drifter trajectories.)

All drifters eventually reached the north boundary of the Gulf Stream and were then transported rapidly eastward with it. The trajectories in Figure 7 clearly show the band of swiftly moving Gulf Stream current that sweeps out an arc from 36.5° N, 74° W to 38° N, 67° W. Some drifters became entrained in rings and eddies, and were ejected from the Gulf Stream back into the Slope Sea. They are seen north of 39°N to the east of the Site. Once ejected from the Gulf Stream, these drifters moved westward, apparently carried in the large, slowly moving, slope-sea gyre that brings them back around toward the 106-Mile Site and eventually southwestward on to the Gulf Stream again.

Buoy Trajectories of 64 Satellite-tracked Buoys Released in the 106 Mile Site Oct89 to Jun91

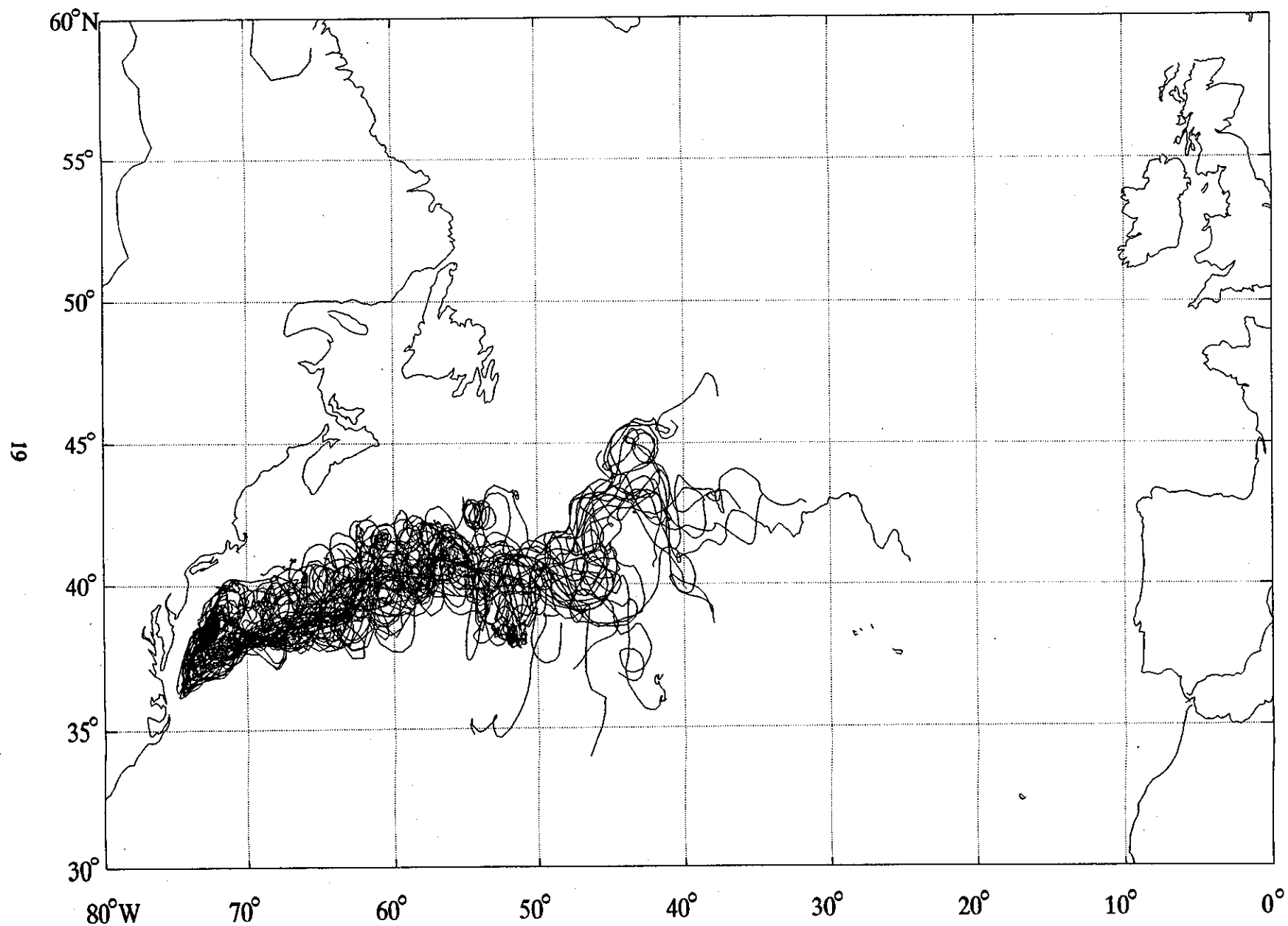


Figure 6. Trajectories of 58 satellite-tracked drifters released at the 106-Mile Site between October 1989 and June 1991.

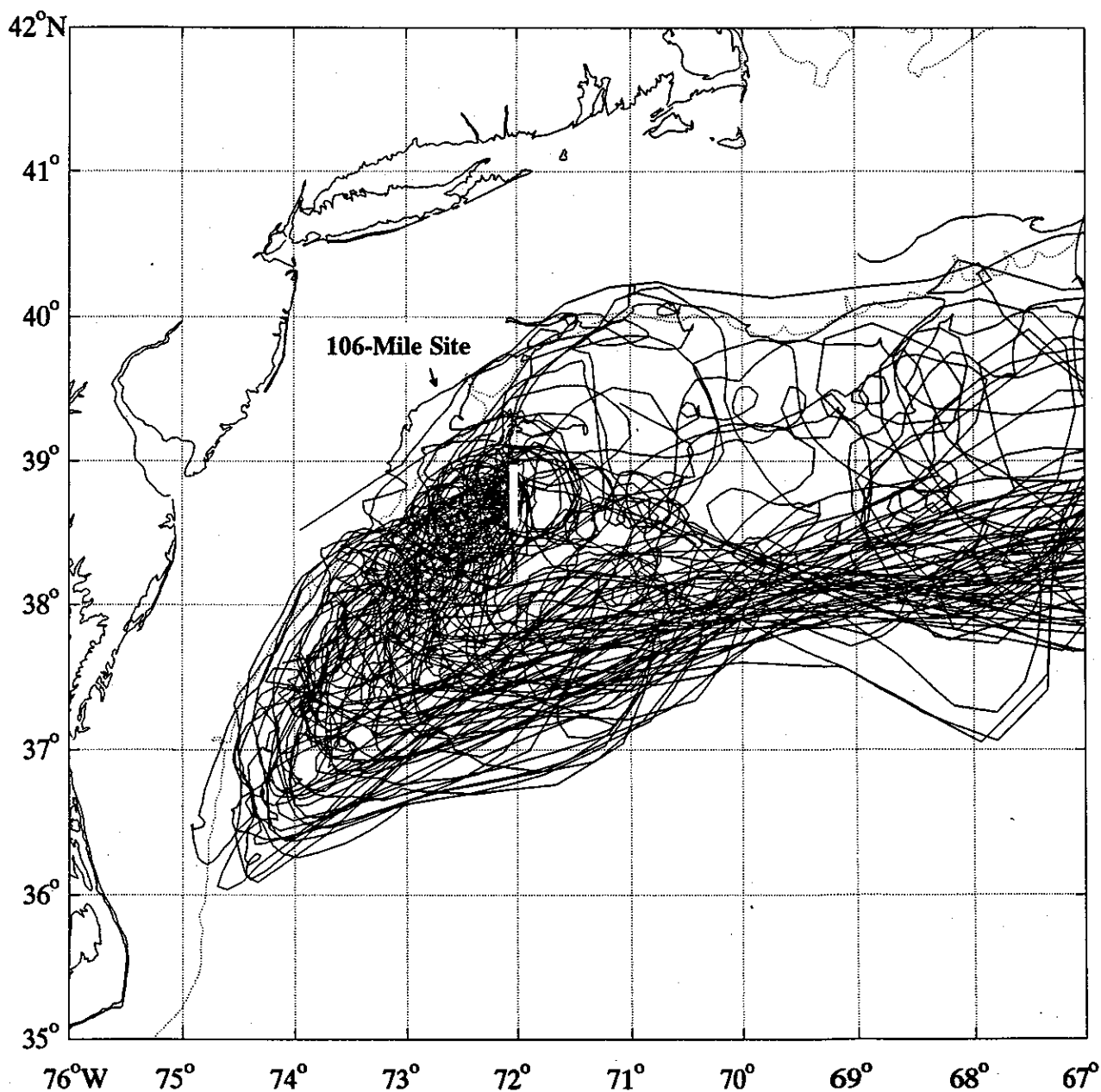


Figure 7. Trajectories of 58 satellite-tracked drifters released at the 106-Mile Site between October 1989 and June 1991 shown in the region of the Mid-Atlantic Bight.

No drifter moved significantly onto the Continental Shelf within the first 2 months after deployment. This is seen clearly in Figure 7. Several drifters just crossed the 200-m isobath, which is the usual delineation of the Continental Shelf/Slope break (shown as a dotted line in Figure 7). Generally, however, these drifters remained within a few kilometers of the break, with the deepest penetration onto the shelf (about 25 km) experienced by drifter 12744. Additionally, the temperature data from these drifters suggest that they did not transit into Continental Shelf water. After skirting along the Shelf/Slope break, they moved back onto the slope and continued southwestward to the Gulf Stream. Drifters 12745 and 12769 can be seen on the Continental Shelf southeast of Nantucket near the end of their deployment lives, after having been carried by the Gulf Stream as far east as 64° W longitude, then leaving the Stream to wander north and west.

Drifter trajectories can be differentiated according to (1) those that remain in or adjacent to the Gulf Stream once entrained (2) those that are ejected from the Stream after some time, and then recirculate toward the Mid-Atlantic Bight and the 106-Mile Site and (3) those deployed directly into Warm Core Rings (WCRs) present at the site. The number, frequency, and duration of drifters that recirculate or are entrained in rings are of interest regarding sludge transport and dispersion. Figures 8(a), (b), and (c) show examples of trajectories for these three patterns. The trajectory shown in Figure 8(a) exhibits the most typical pattern, where the drifter moves southwestward from the Site along local isobaths until entrained in the north wall of the Gulf Stream and then eastward with the Stream. Figure 8(b) shows a drifter whose trajectory was typical of the recirculating type. This drifter also moves southwestward from the Site, then eastward with the Gulf Stream, but later is ejected from the Stream in a small eddy which moves slowly westward, and eventually directly through the 106-Mile Site again. Those recirculating drifters that transitted long enough eventually reached the Gulf Stream again and were carried eastward with it as this example shows. Figure 8(c) shows a drifter whose trajectory was typical of those deployed in WCRs as they moved through the Site. This drifter is moved rapidly out of the Site by the swiftly spinning ring, but translates slowly to the southwest corresponding with the slowly moving mean position of the ring.

3.3 Statistical Analysis

Using the 58 drifter trajectories described previously, the drifter positions at several intervals after deployment were determined and statistics calculated. Figure 9(a)-(d) shows the drifter positions at

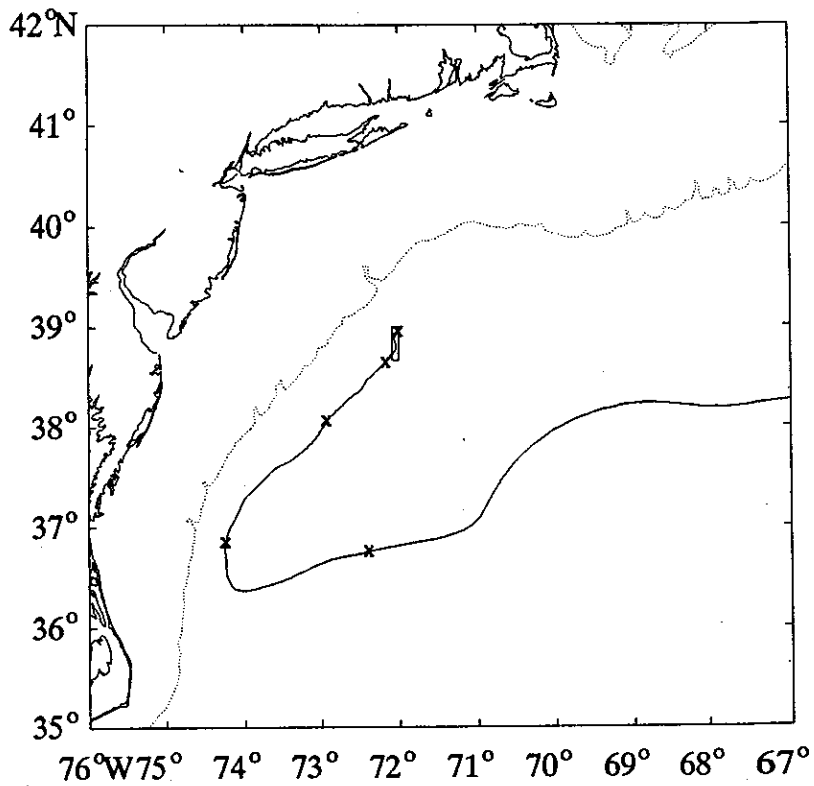


Figure 8(a). Trajectory of satellite-tracked drifter no. 12740 released at the 106-Mile Site June 13, 1990 showing typical southwestward slope-sea and subsequent eastward Gulf Stream movement. Tic marks indicate 1 week intervals.

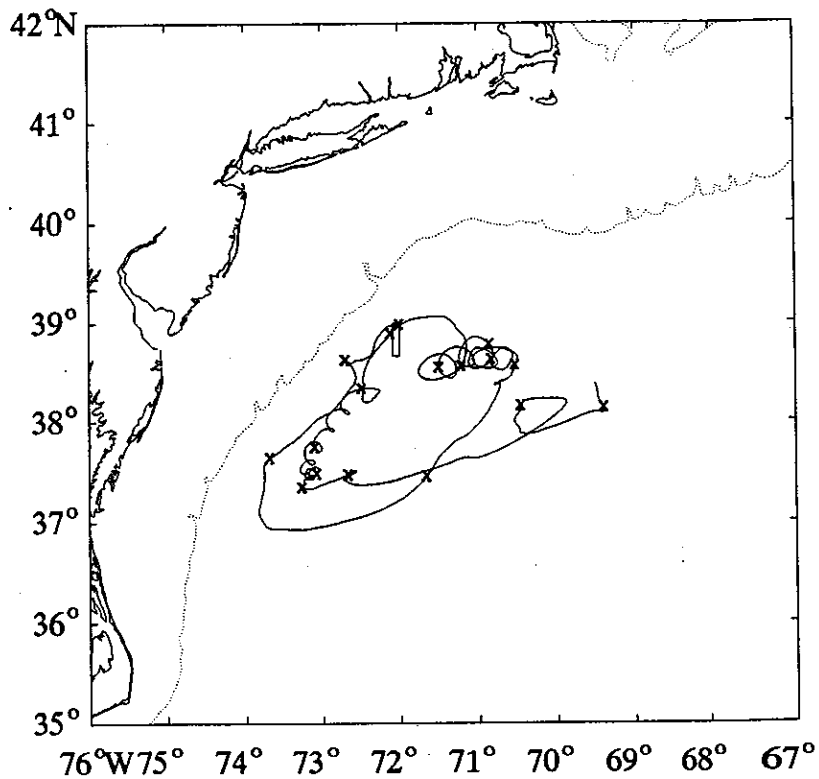


Figure 8(b). Trajectory of satellite-tracked drifter no. 9324 released at the 106-Mile Site January 11, 1990 showing typical slope-sea recirculating movement. Tic marks indicate 1 week intervals.

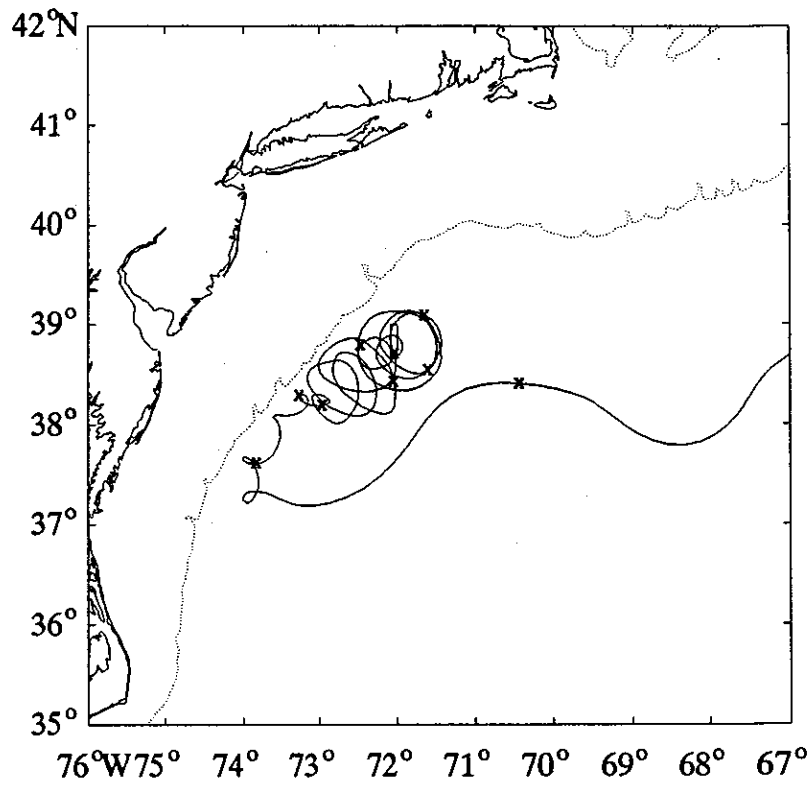


Figure 8(c). Trajectory of satellite-tracked drifter no. 12760 released at the 106-Mile Site December 15, 1990 showing typical warm core ring associated movement. Tick marks indicate 1 week intervals.

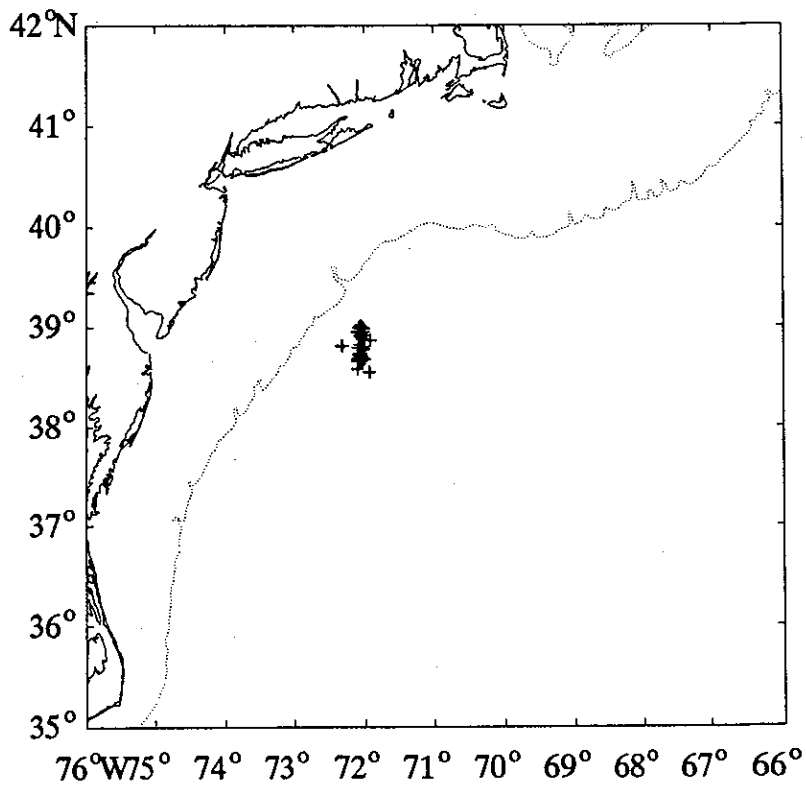


Figure 9(a). Positions of 58 satellite-tracked drifters at deployment.

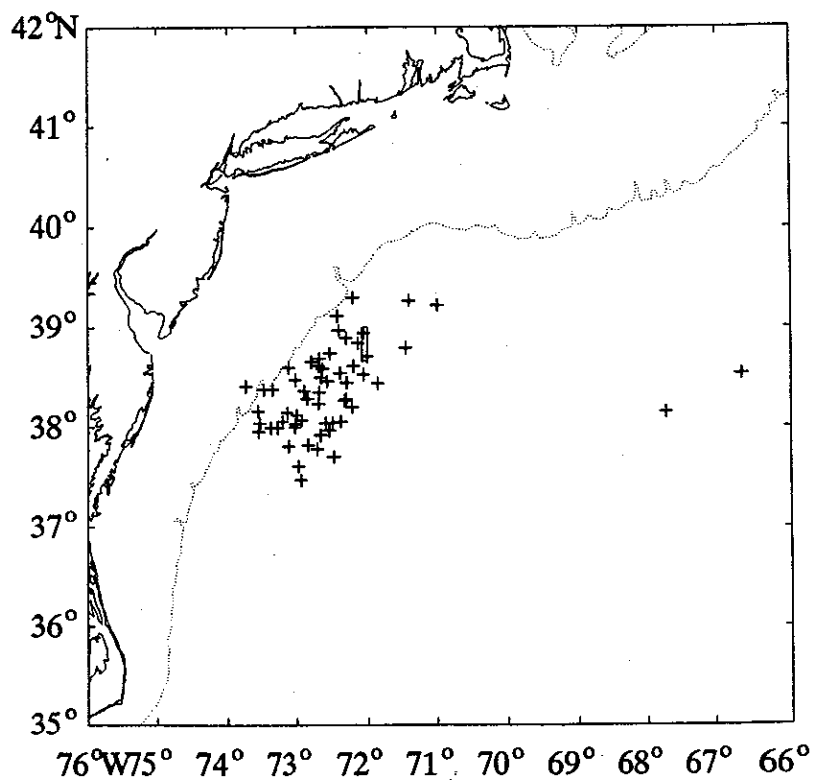


Figure 9(b). Positions of 58 satellite-tracked drifters 1 week after deployment.

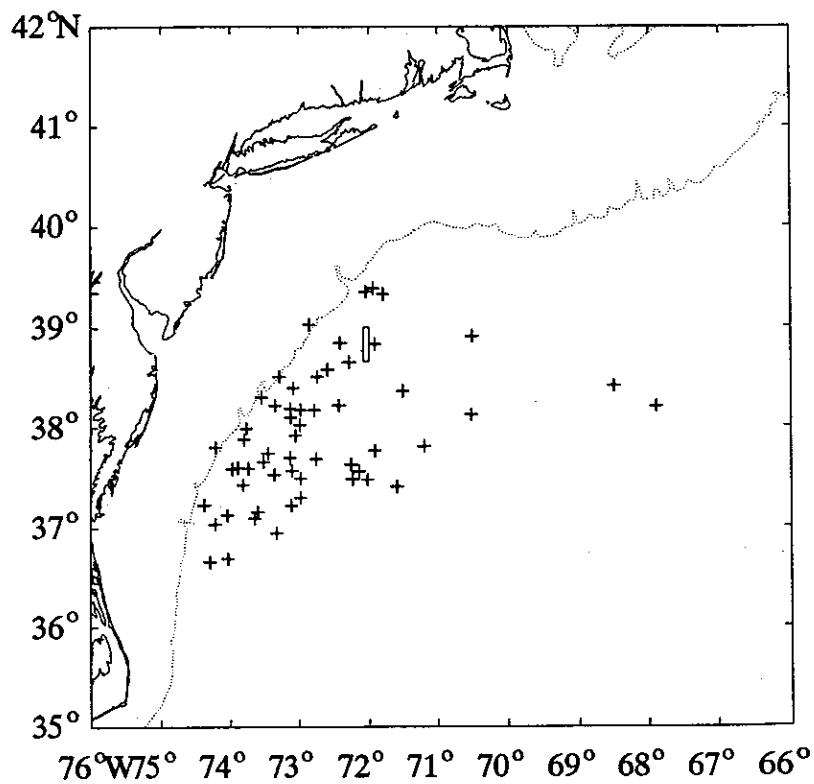


Figure 9(c). Positions of 58 satellite-tracked drifters 2 weeks after deployment.

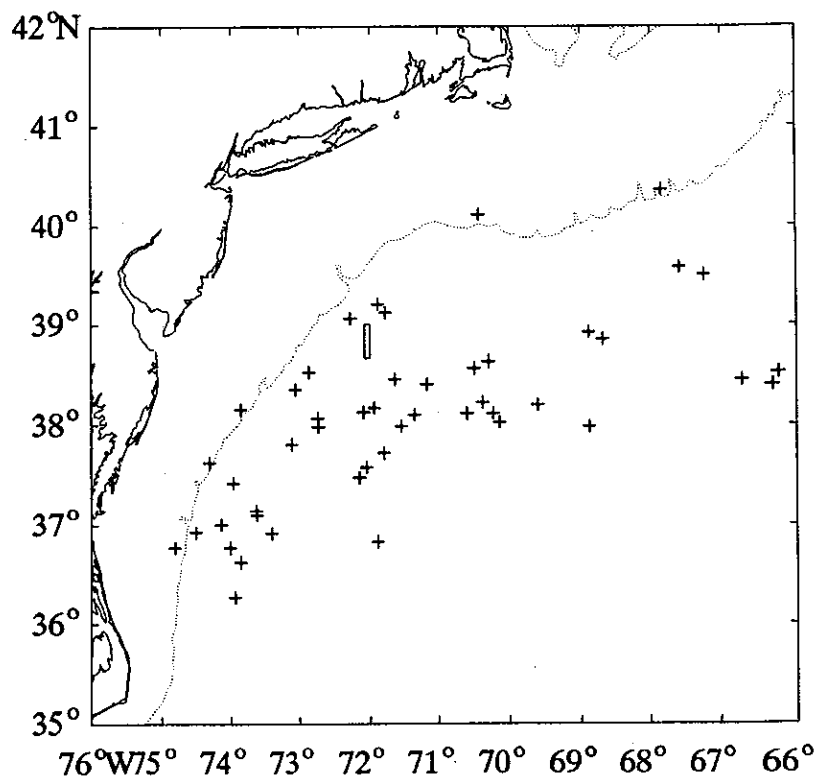


Figure 9(d). Positions of 58 satellite-tracked drifters 4 weeks after deployment.

deployment, one week, two weeks, and four weeks after deployment. This sequence suggests the dispersion pattern that might be observed if all drifters were deployed simultaneously and if the governing process were statistically stationary. But the process is not stationary and one must consider the pattern as a "smearing" of a non-stationary process over time. Despite this, the pattern that emerges demonstrates some very consistent features of the flow field over the 23-months of drifter deployments. The sequence clearly shows the dominant motion of the drifters to the southwest immediately after their deployment and their simultaneous dispersion. Note also that those drifters which were transported westward never crossed the Shelf/Slope break (shown in Figure 9 as the 200m isobath). The Shelf/Slope break seems to present an effective barrier to any drifters moving onto the Continental Shelf. Table 5 summarizes these results for intervals out to eight weeks after deployment. Note that this table presents the distance **travelled** by the drifters and not the straight line distance from the 106-Mile Site. Particles with a settling velocity of 0.04cm/s, which corresponds to a heavy fraction in the sludge plume, (Lavelle, 1988), will take 8 weeks to settle 2000m, and from table 5, the mean distance travelled by the drifters in 8 weeks was over 2300 km.

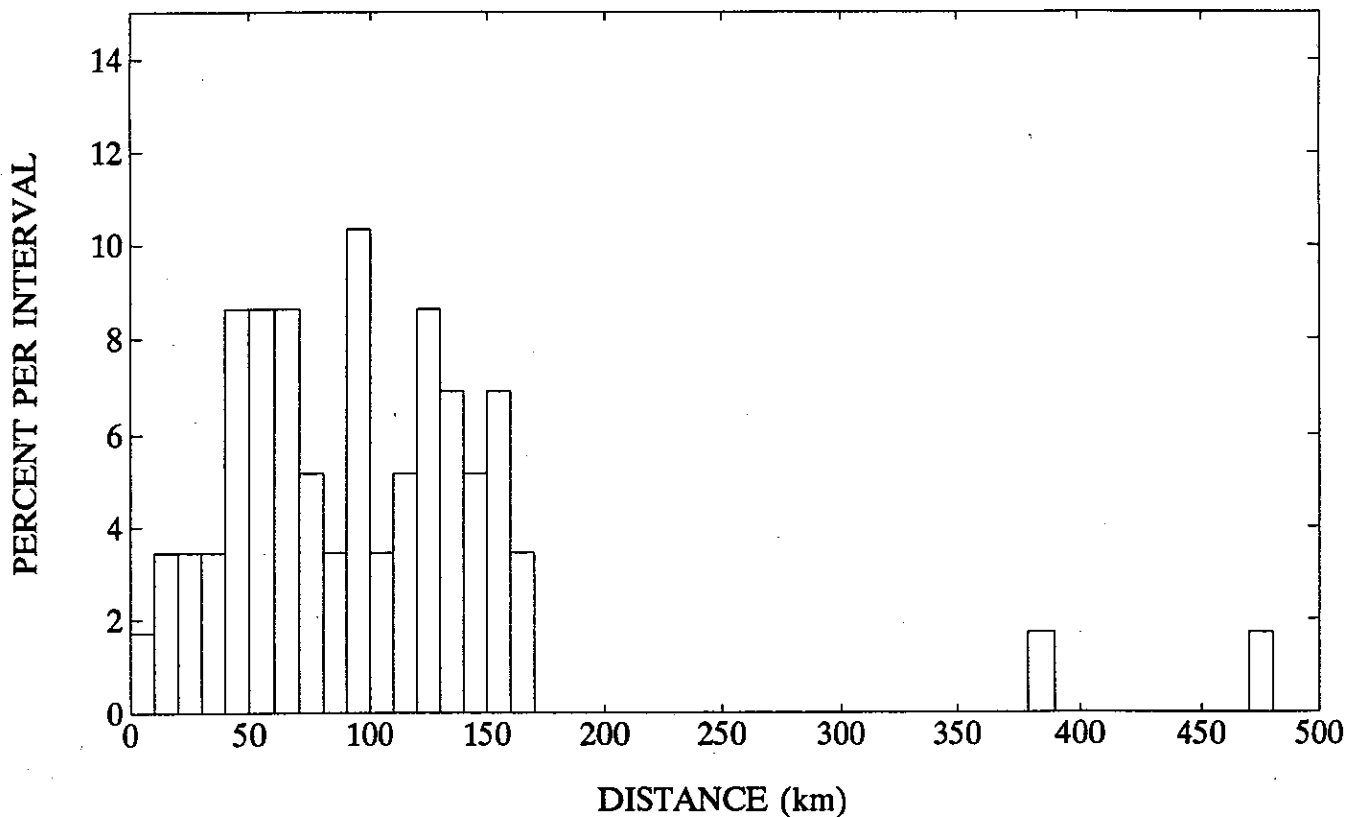
Figure 10 shows the distance and direction of all 58 drifters relative to their 106-Mile Site deployment position after 1 week. The mean distance from the Site was about 102 km and the mean direction was 236°. Over 85% of the drifters exited the Site to the southwest quadrant.

In order to characterize the residence time of drifters in the Slope Sea, the positions of all 58 drifters were hand digitized from the trajectory maps at various features. These include: (1) the locations where any drifters first crossed the Shelf/Slope break, (2) the intersection of the drifters with the north wall of the Gulf Stream based on the drifter temperature and velocity records, and (3) the approximate point of closure of the slope-sea gyre for any drifters that recirculated. The results are presented in Table 6. One way or another, all of the drifters arrived at the north wall of the Gulf Stream. The mean time to travel the Gulf Stream was about 29 days, which corresponds to a mean speed of about 16 cm/s. The modal time was 24 days, indicating that the distribution was skewed. The corresponding modal velocity was approximately 20cm/s. While none of the drifters crossed the Shelf/Slope front and remained in Continental Shelf water, it is of interest that 9 of the 58 drifters did reach the break, and the mean time to do so was only 9 days. There was no apparent grouping in time of those drifters that reached the Shelf/Slope break. Finally, after reaching the Gulf Stream 41 of the drifters were carried directly eastward by its influence and out of the general area. The remaining 17 drifters were ejected northward from the Gulf Stream and began to recirculate westward

Table 5. Distance Traveled by 58 Drifters Released at the 106-Mile Site.

Time Interval	Number of Drifters	Distance Traveled (km)			
		Mean	Min	Max	Std Dev
1 Week	58	109	89	498	89
2 Weeks	58	396	202	1429	202
4 Weeks	58	965	385	2136	433
8 Weeks	57	2319	1105	4785	802

HISTOGRAM OF DISTANCE FROM SITE AFTER 1 WEEK



HISTOGRAM OF DIRECTION FROM SITE AFTER 1 WEEK

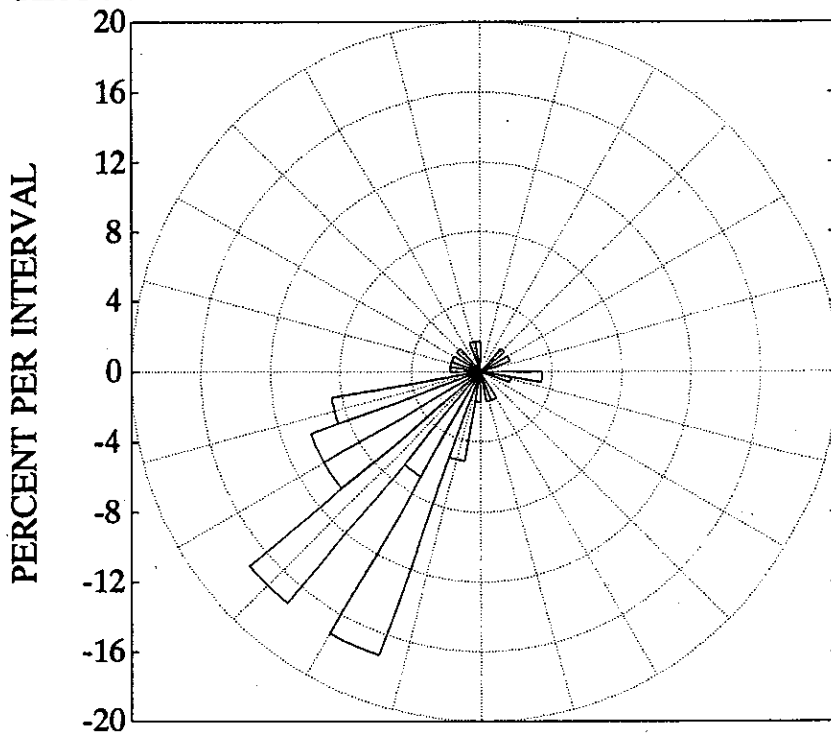


Figure 10. Distance and direction from 106-Mile Site of satellite-tracked drifters 1 week after deployment.

Table 6. Time Required for 58 Drifters to Travel to the Shelf/Slope Break, the Gulf Stream, and to Recirculate in the Slope-sea Gyre. Times based on digitized positions for drifters crossing the Shelf/Slope break, the point of interaction with the north wall of the Gulf Stream (as indicated by drifter temperature records), and the approximate point of closure in the slope-sea gyre for recirculating drifters.

	Number of Drifters	Time (days)			
		Mean	Min	Max	Std Dev
Shelf/Slope Break	9	12	4	26	7
Gulf Stream	58	29	4	109	18
Recirculate	17	62	28	110	24

in the slope-sea gyre. The time to recirculate back to the Site (i.e., the period of the slope-sea gyre), was approximately 2 months.

3.4 Lagrangian Statistics

Velocities can be calculated from drifter position data, but these are Lagrangian velocities, i.e., the velocities of particles moving with the water. Another meaningful measure is the average drifter velocity computed over an area, which can be compared to the Eulerian flow velocity — that which is measured by a stationary current meter. As a drifter passes through a grid square (the area over which we choose to average), not all the velocities reported by that drifter are statistically independent. Velocities from many drifters are necessary to produce a statistically significant long-term average of flow velocity in the grid squares.

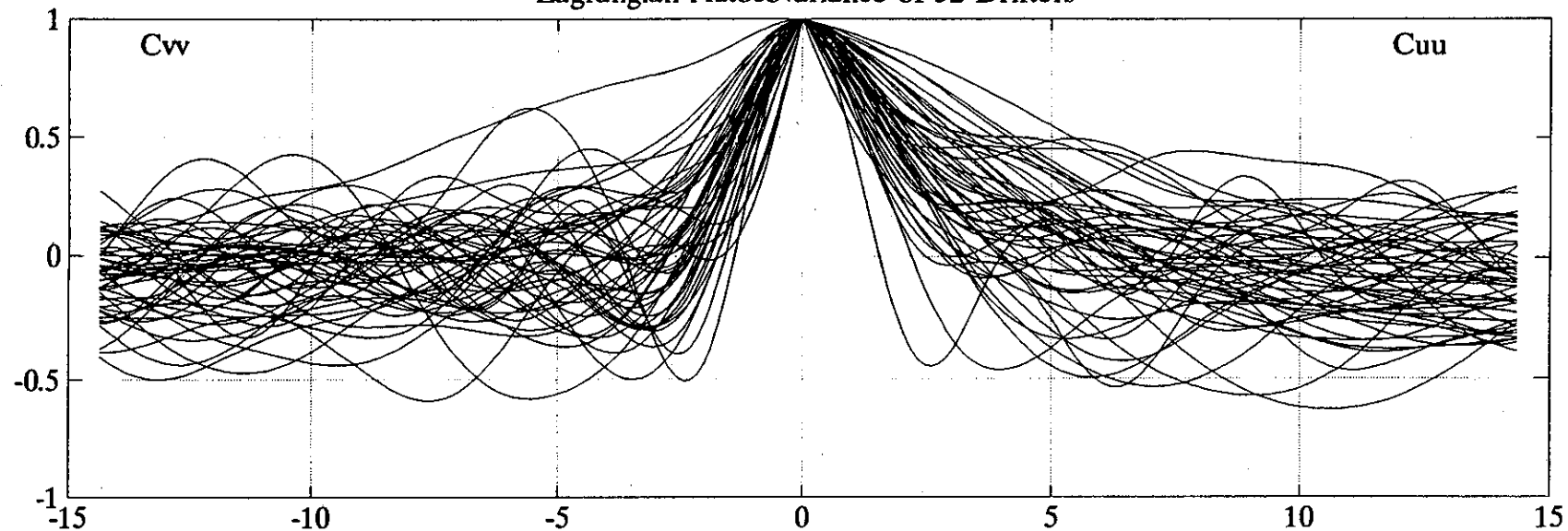
The time scale of statistical independence is the so-called Lagrangian integral time scale. It is the time interval over which the calculated drifter velocities u are uncorrelated. It is calculated in usual practice by integrating the ensemble average of the normalized velocity autocovariance function from zero to the time of the first zero crossing. The integral time scale for these drifters was estimated in this fashion (see Figure 11) at 2.3 days in the along-isobath (u) direction and 1.4 days in the cross-isobath (v) direction. Once the integral time scales have been calculated the Lagrangian integral length scales can be determined as the product of the integral time scale and the square root of velocity variance. The integral length scales were found to be 61 km and 51 km respectively.

Using the integral time scale, the standard error for the velocity estimates can be calculated at 95% confidence levels from the Student- t test by

$$\frac{2\sqrt{u'^2}}{\sqrt{N}},$$

$\sqrt{u'^2}$ is the standard deviation of the velocity over time and all realizations for a grid square. If we have n observations and T is the Lagrangian time scale, then we have $N = n/T$

Lagrangian Autocovariance of 52 Drifters



Mean Lagrangian Autocovariance of 52 Drifters

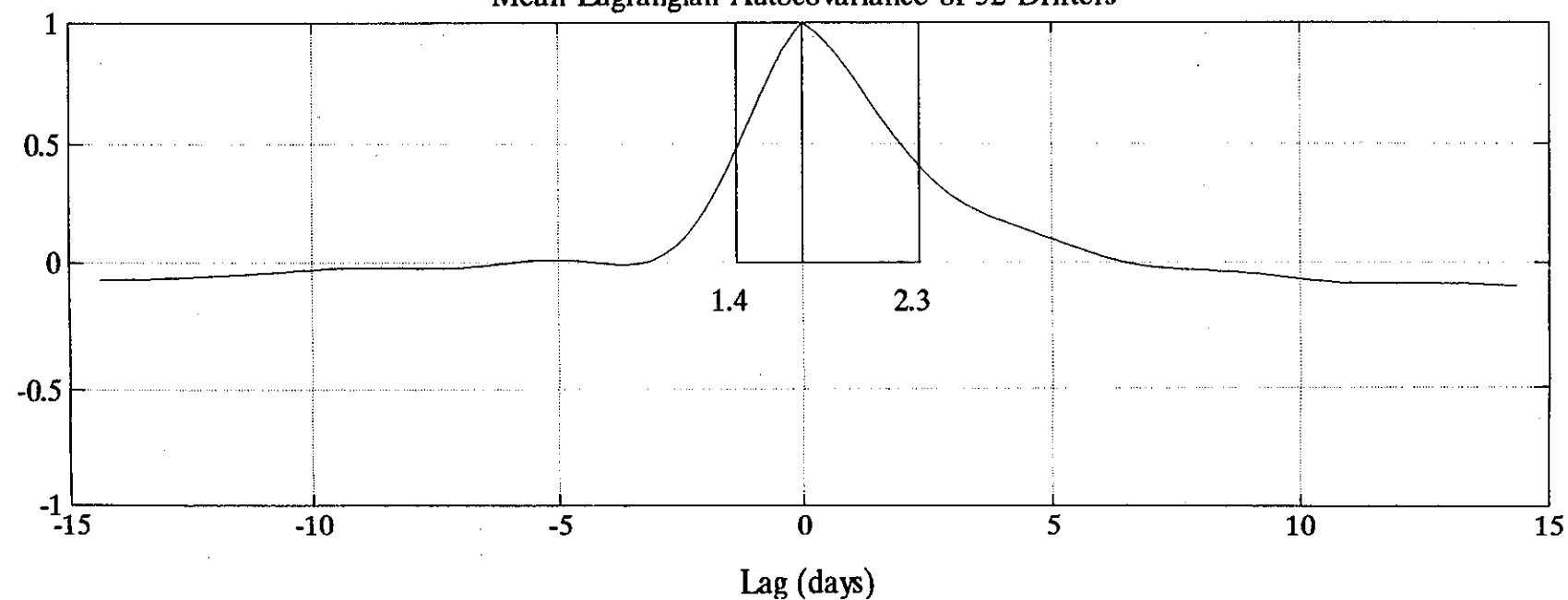


Figure 11. Normalized autocovariance function for the along- (u) and cross-isobath (v) directions for 52 drifters. Six drifters which were deployed in rings have been omitted.

statistically independent data points. Standard error is inversely proportional to the square root of the equivalent number of independent observations; the number of statistically significant mean values increases as the number of drifters increases or as the grid size is increased.

Figures 12(a) and (b) show the Lagrangian velocities calculated over a grid of $0.5^\circ \times 0.5^\circ$ squares. Figure 12(a) presents velocity vectors from all drifter data, whereas Figure 12(b) includes only those velocities that are greater than the standard error (they appear in the grid squares that are visited most frequently by drifters). The arrows indicate the speed and direction of the mean velocity over the grid square; the arrow tail is location at the center of the square. The principal axes for the current variances for each grid square are plotted in Figure 13. Figures 12 and 13 reveal several features characteristic of the surface flow field in the Slope Sea and adjacent waters. A coherent mean southwest flow is apparent in the Slope Sea from the 106-Mile Site to just northeast of Cape Hatteras. There is no cross-shelf component to this flow and the mean drift speeds are about 18-20 cm/s. The relatively high current variances ($25\text{cm}^2/\text{s}^2$) within this zone tend to be isotropic. The location of the Gulf Stream and the magnitude of the velocities associated with it are visible from northeast of Cape Hatteras to the eastern edge of the grid at 68° W. Mean drift speeds as high as 100 cm/s towards the east-northeast were observed for drifters entrained in the Gulf Stream. The strong southeastward mean flows that are visible in the southeastern region of the grid correspond to Gulf Stream meanders toward the southeast in this region and do not represent the mean Gulf Stream velocity. This is also reflected in the strongly asymmetrical variance in this region. Present only in Figure 12(a) are mean westward currents in the north central portion of the grid, which complete the large-scale slope-sea gyre that has recirculated some of the drifters.

Following Taylor's (1921) theory for single particle dispersion in homogeneous isotropic turbulence, the horizontal eddy diffusion coefficients K_{kk} of a particle are determined by

$$K_{kk} = \frac{1}{2} \frac{d}{dt} \langle x_k^2 \rangle$$

where $\langle x_k^2 \rangle$ is the mean-square dispersion or variance of the position vector x_k in the k-direction.

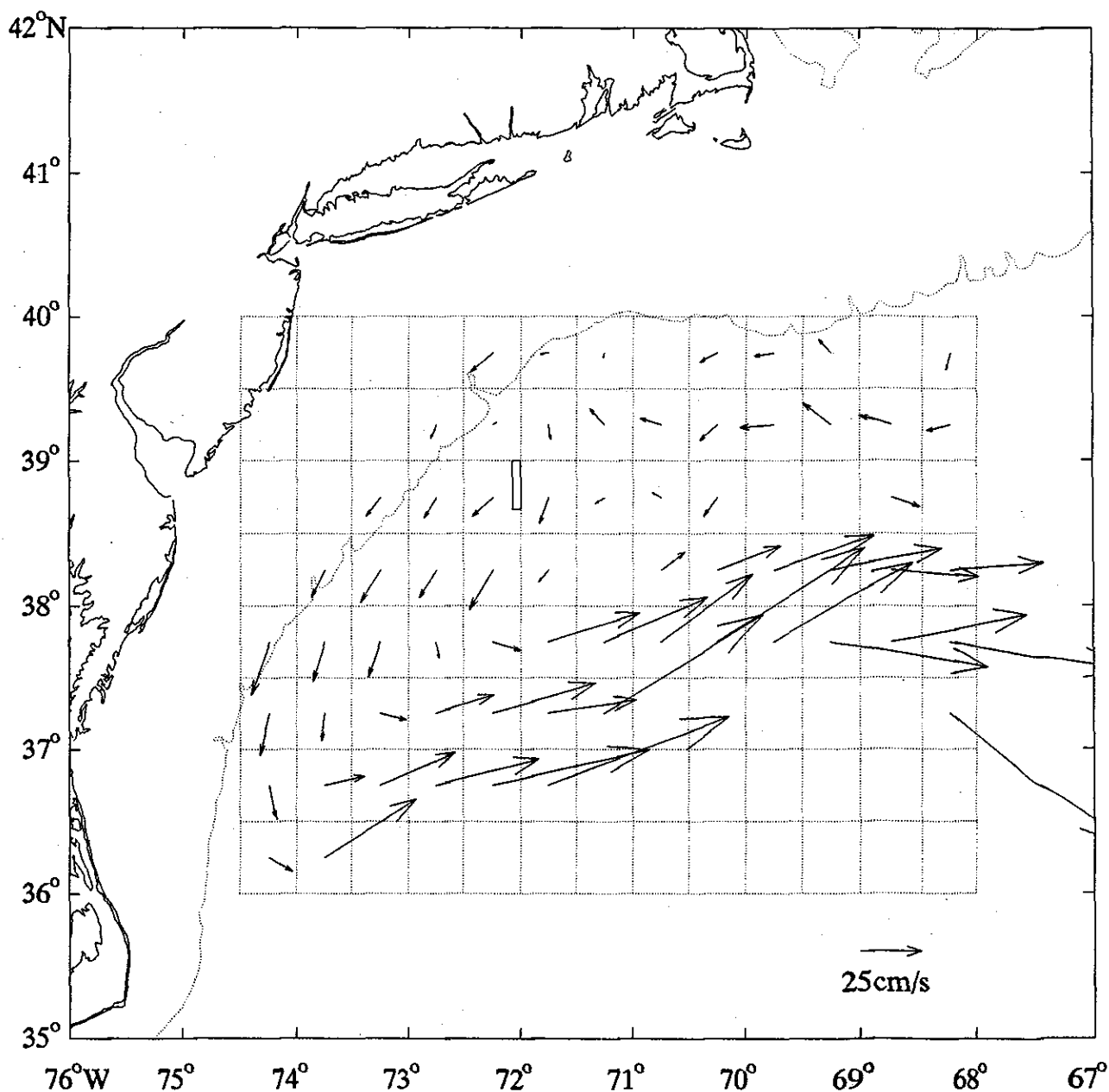


Figure 12(a). Mean Lagrangian surface currents from 58 drifters over $0.5^\circ \times 0.5^\circ$ grid squares. Grid squares through which no drifters passed are left blank.

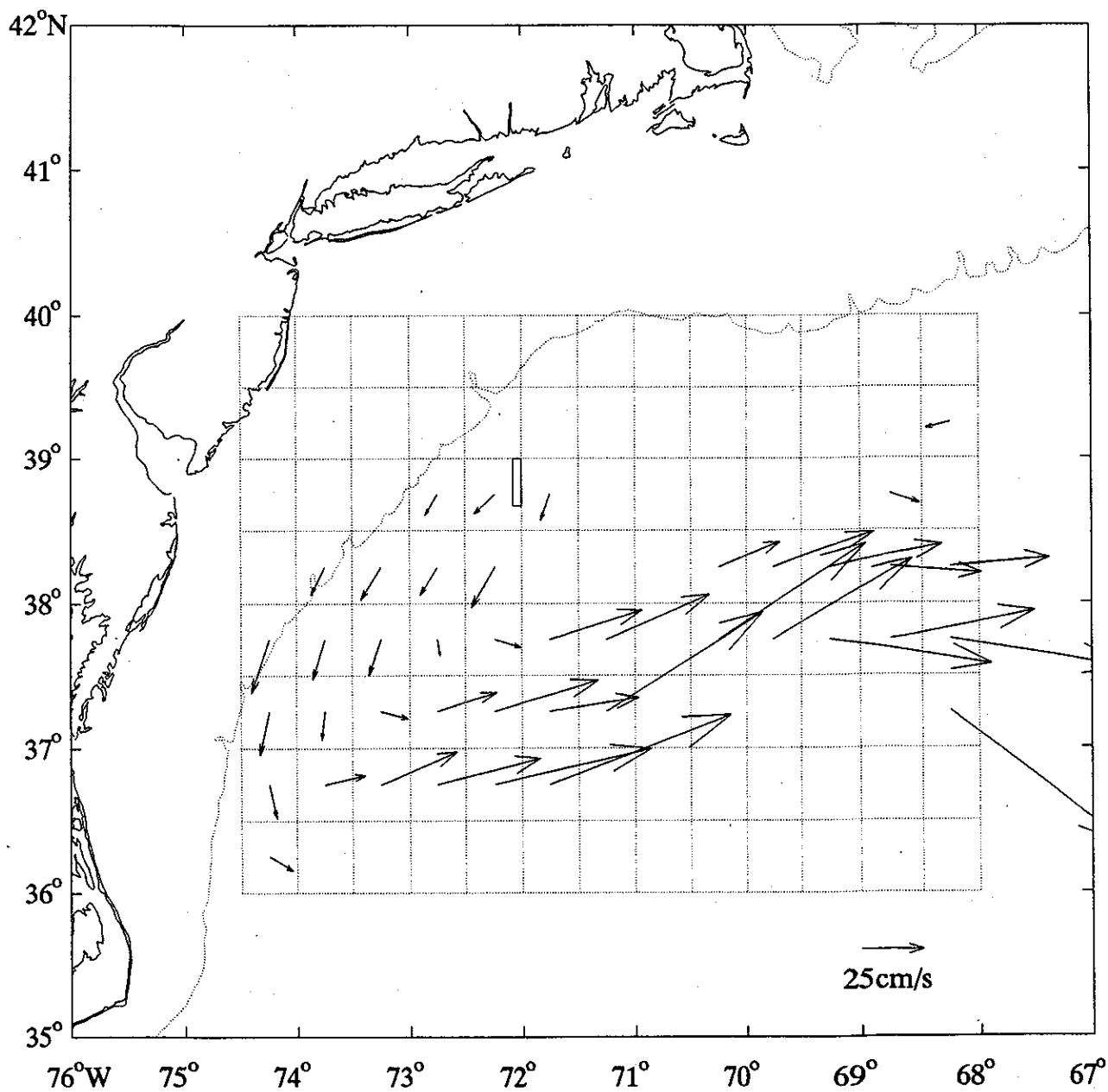


Figure 12(b). Mean Lagrangian surface currents from 58 drifters over $0.5^\circ \times 0.5^\circ$ grid squares. Only those velocities greater than the standard error are shown.

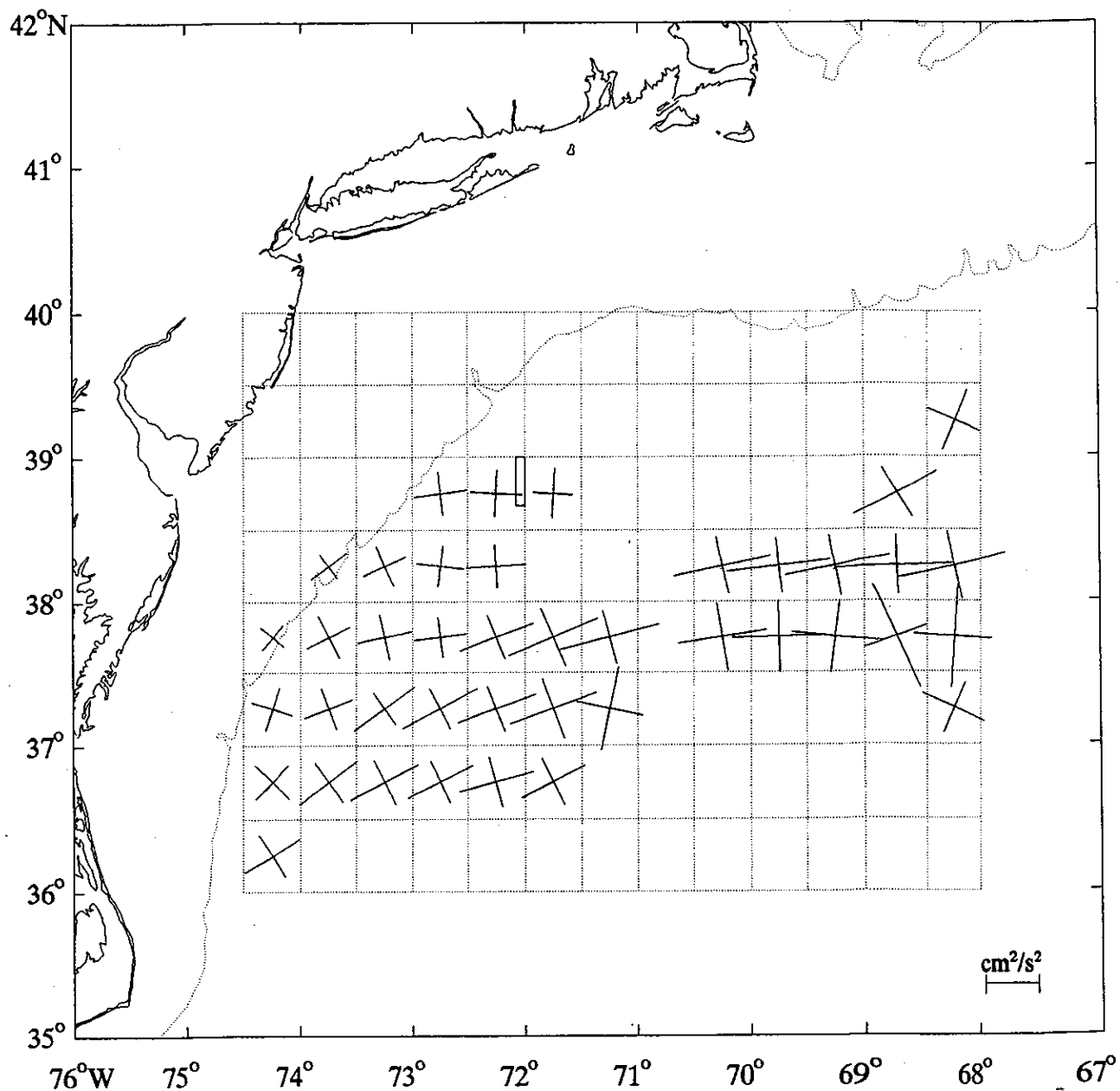


Figure 13. Principal components of velocity variance from 58 drifters over $0.5^\circ \times 0.5^\circ$ grid squares. Only those variances are shown where the mean velocity is greater than the standard error.

This can be calculated directly. To avoid the influence of the Gulf Stream we have limited the data to the first 20 days and calculated diffusion coefficients for the Slope Sea waters of the 106-Mile Site for those 20 days. Those drifters deployed in WCRs or which obviously felt the influence of the Gulf Stream during their first 20 days have been omitted from these calculations. The coordinate system has been rotated into the along- (u) and cross-isobath (v) directions with u directed toward 217°. Figure 14 shows 43 drifter paths in the along- and cross-isobath directions all emanating from the same point. As indicated by the positive along- and cross-isobath displacements during the first 12-15 days the mean position of the drifters shifts toward the southwest and offshore. The offshore movement is consistent with the Shelf/Slope front limiting the shoreward movement of the drifters. After 12-15 days, the influence of the Gulf Stream is visible in the negative along-isobath and positive cross-isobath displacements.

The along- and cross-isobath mean-square dispersions calculated from the drifter displacements are shown in Figure 15. The mean-square dispersion increases roughly uniformly throughout the first 12 days which suggests a random-walk regime. After that, however, the drifters begin to separate much more rapidly due to the influence of the energetic Gulf Stream currents. The turbulence here is anisotropic, since the along-isobath dispersion is significantly greater than the cross-isobath dispersion.

The diffusion coefficients in the along- and cross-isobath directions have been calculated by differentiating the dispersion curves with respect to time. The results are presented in Figure 16. The diffusion coefficients calculated from the dispersion curves are noisy, but estimating them for the first 12 days gives $K_{uu} = 3.7 \times 10^7 \pm 1.8 \times 10^7 \text{ cm}^2/\text{s}$ and $K_{vv} = 1.3 \times 10^7 \pm 0.5 \times 10^7 \text{ cm}^2/\text{s}$. After 12 days the influence of the Gulf Stream appears to significantly distort the estimates.

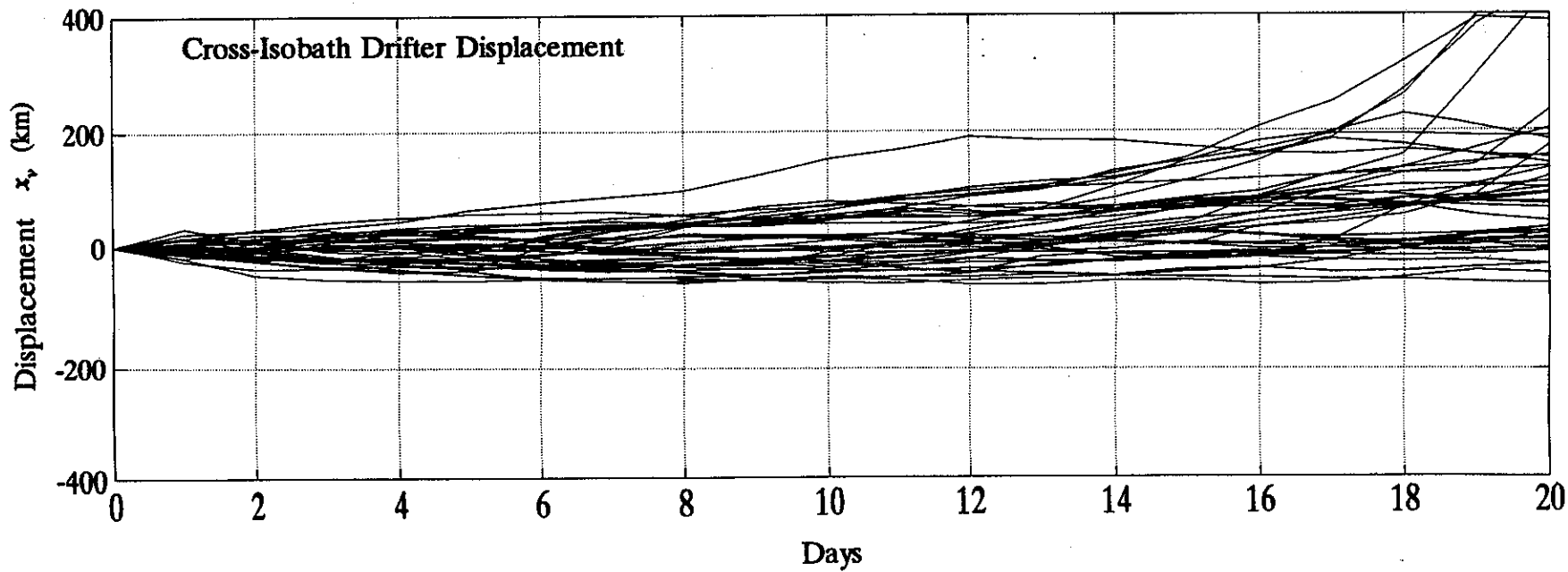
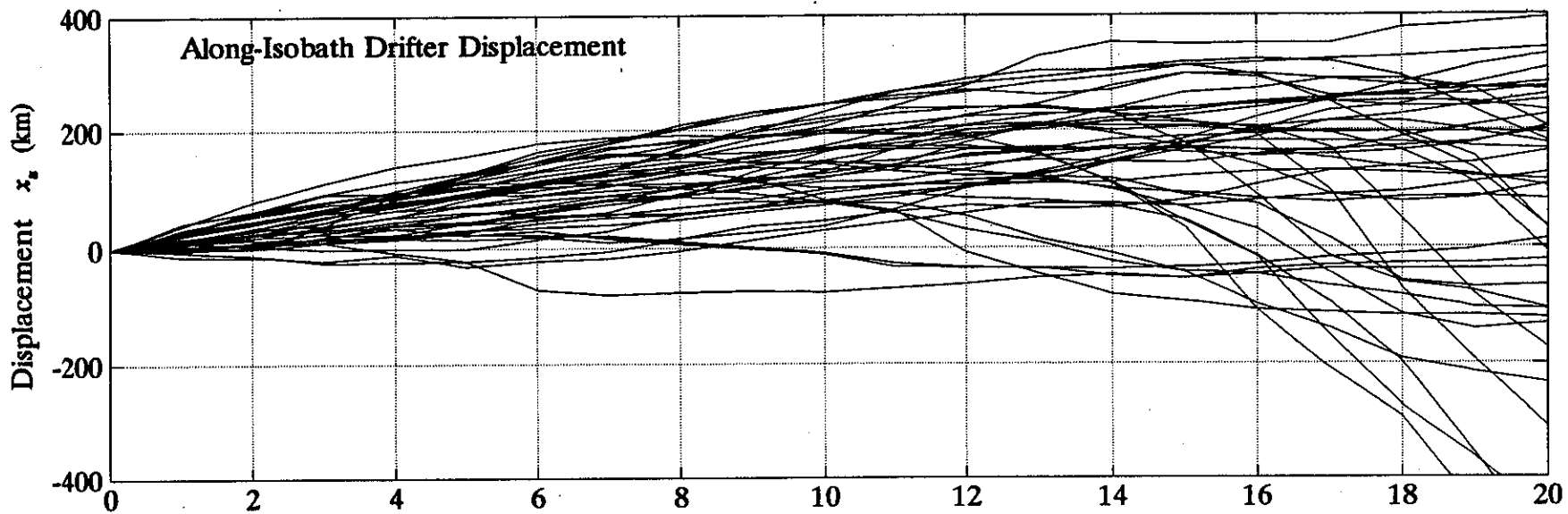


Figure 14. Displacement with time of 43 drifters plotted from a common origin for the along- (u) and cross-isobath (v) components. Positive along-isobath is directed toward 217° .

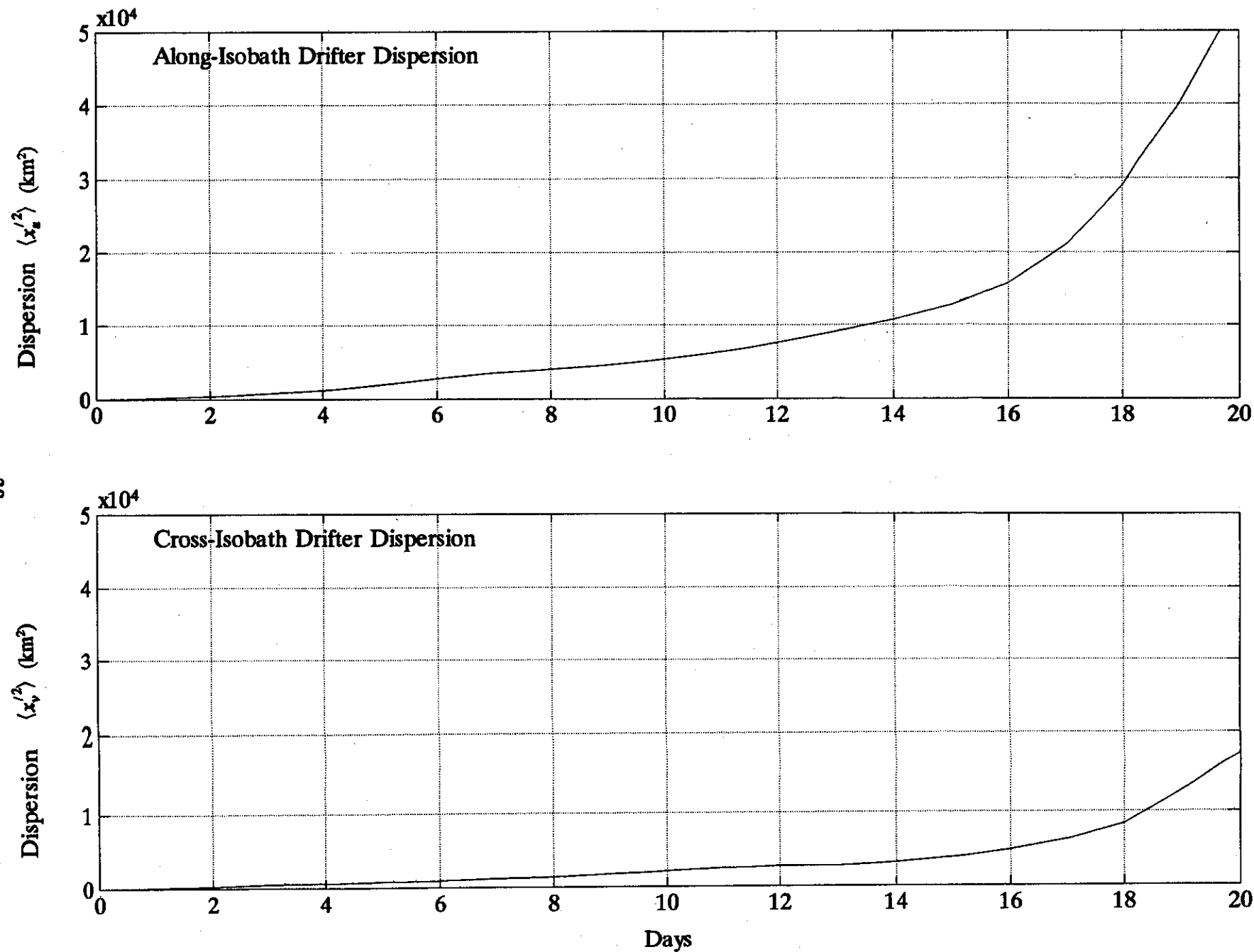


Figure 15. Mean-square dispersion (km²) with time of the 43 drifters for the along- and cross-isobath components.

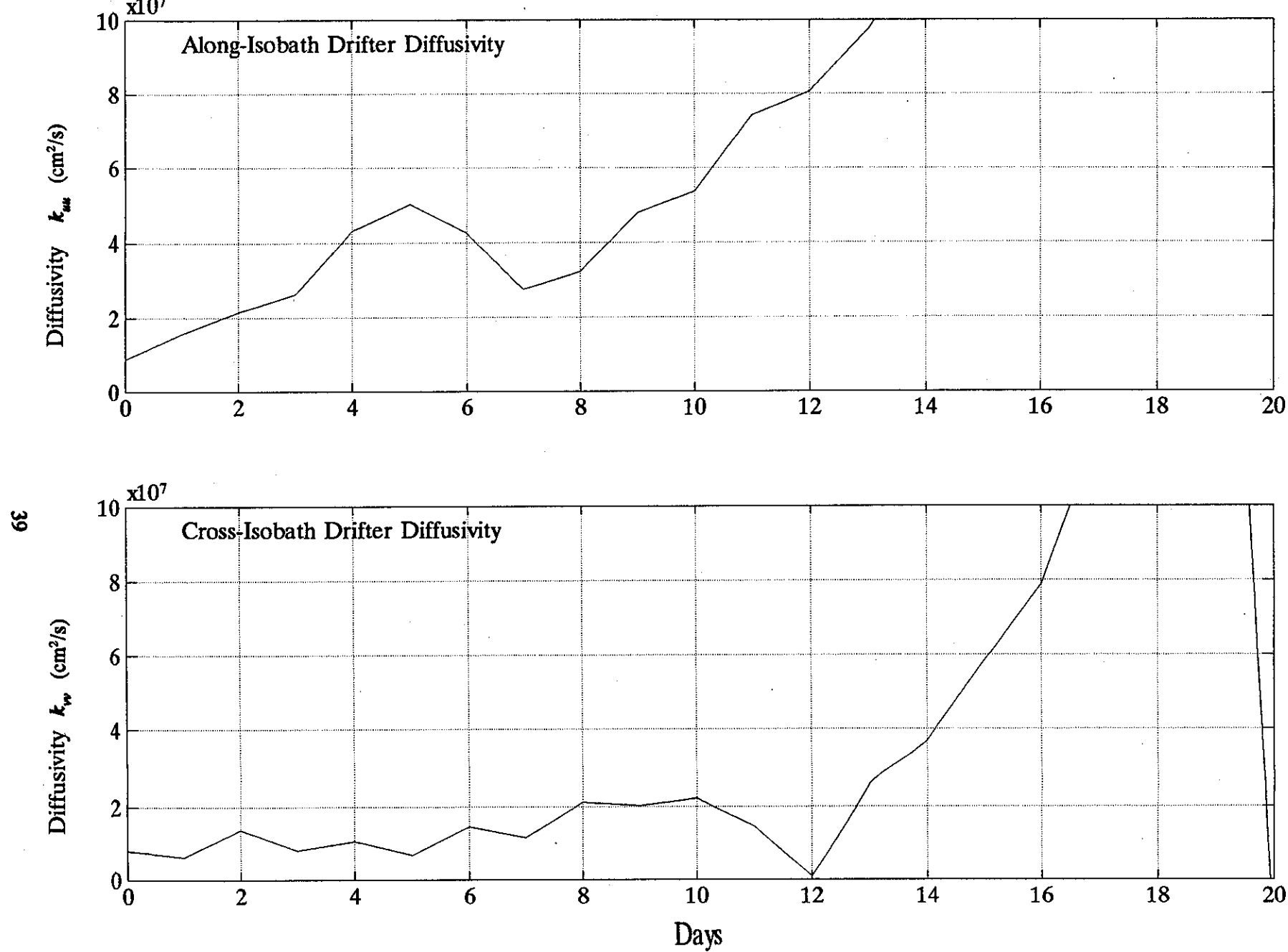


Figure 16. Amplitude of the along- and cross-isobath eddy diffusivity (K_u and K_w) calculated from the gradient of the dispersion curves.

4.0 DATA PRODUCTS

Data for the drifters deployed from October 1989 through December 1990 are presented in Appendix A. Data for 35 drifters that were still transmitting data on or deployed after December 31, 1990, are presented in Appendix AA. Drifters 12757 and 12777 are given for the sake of completeness, but their drogue indicators reported that their drogues were lost, and so trajectories reported and presented are not considered reliable. For each drifter presented in the Appendix, three figures are shown. Those labeled "(a)" show the drifter trajectories plotted on a chart of the North Atlantic so that the entire 4-month record may be viewed at once. The drifter number, deployment date, and date of last transmission are given in the Figure caption. Those labeled "(b)" show the trajectories in an enlargement of the Mid-Atlantic Bight area for a clearer presentation of drifter motions in the vicinity of the 106-Mile Site, in Slope Sea water, and at the slope-shelf front. The 200-m isobath is shown as a dotted line and represents the edge of the Continental Shelf and the approximate boundary between the shelf water and slope water. Figures labeled "(c)" show the time-series plots of data transmitted from the drifters. These include sea-surface temperature, drogue status indicator, and low-battery flag; the calculated change in position is also shown. Change in position is used as a diagnostic to identify drifters picked up by vessels or to indicate other position errors. These data have been checked for quality to remove transmission errors, wild points, and outliers.

5.0 REFERENCES

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APPENDIX A DRIFTER DATA

This appendix presents only those data from drifters deployed from October 1989 through December 1990.

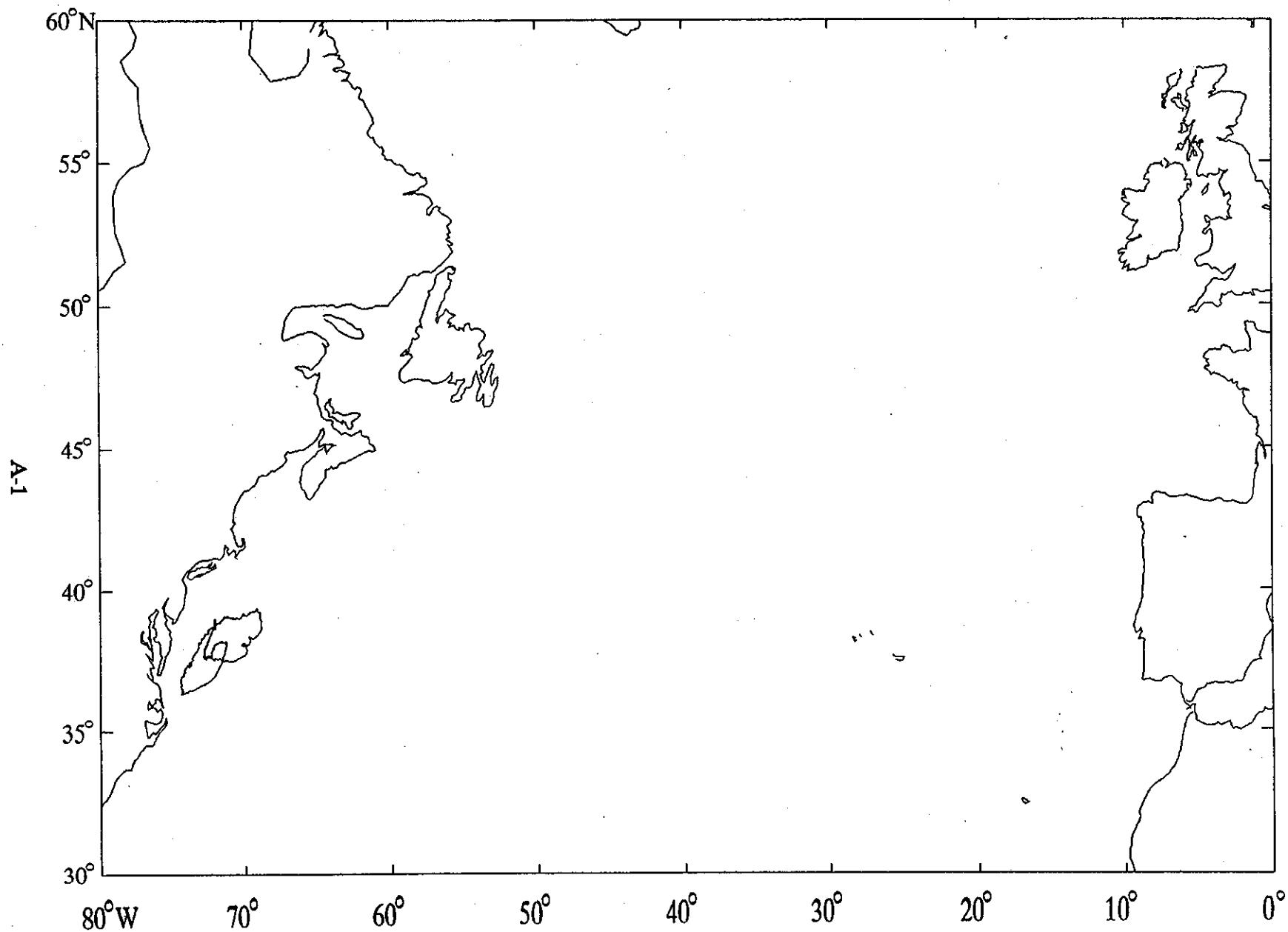
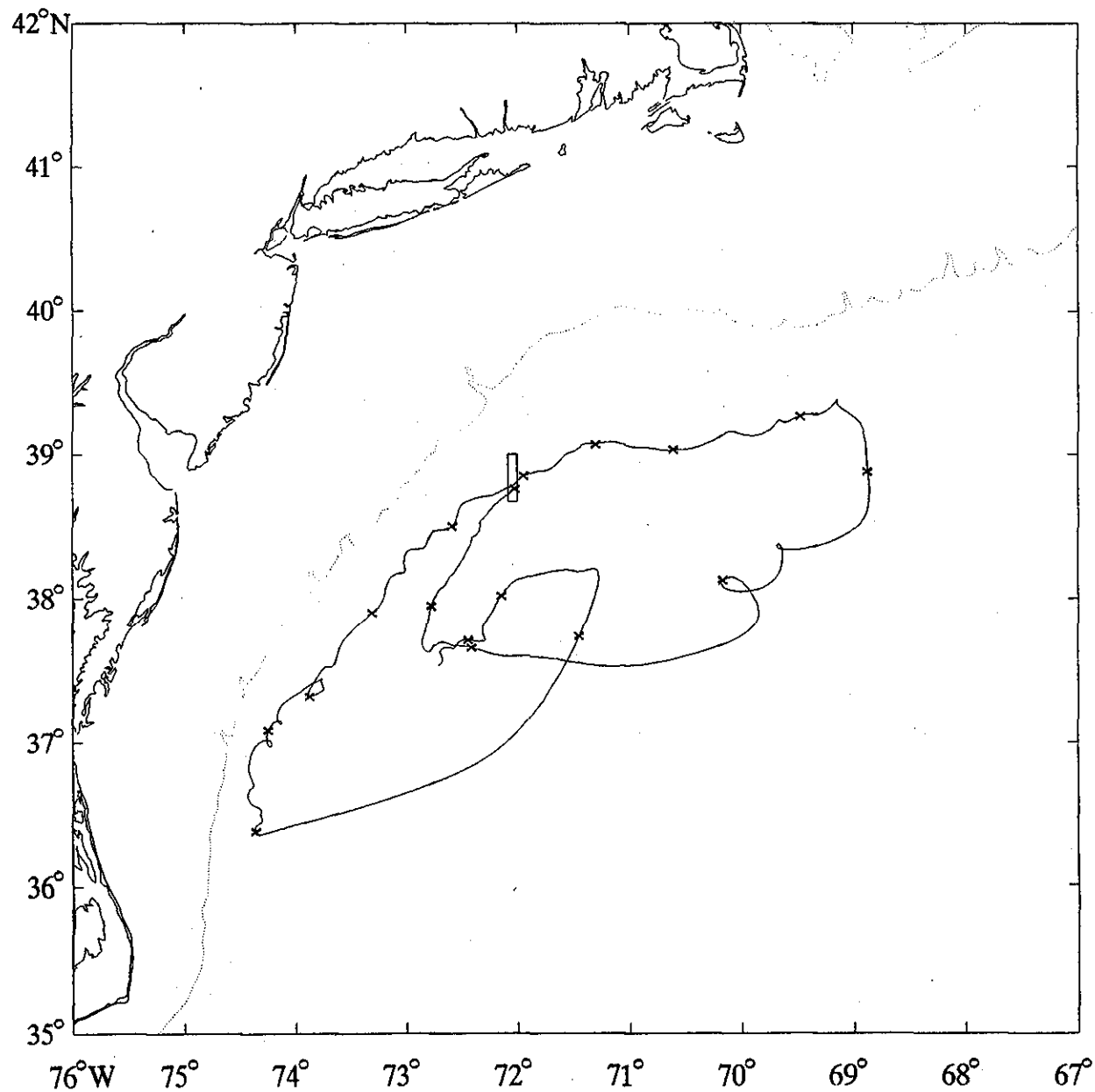


Figure A-1(a). Trajectory of Drifter Number 09320 Deployed on October 25, 1989.

The last transmission was on February 17, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-1(b). Trajectory of Drifter Number 09320 Deployed on October 25, 1989,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

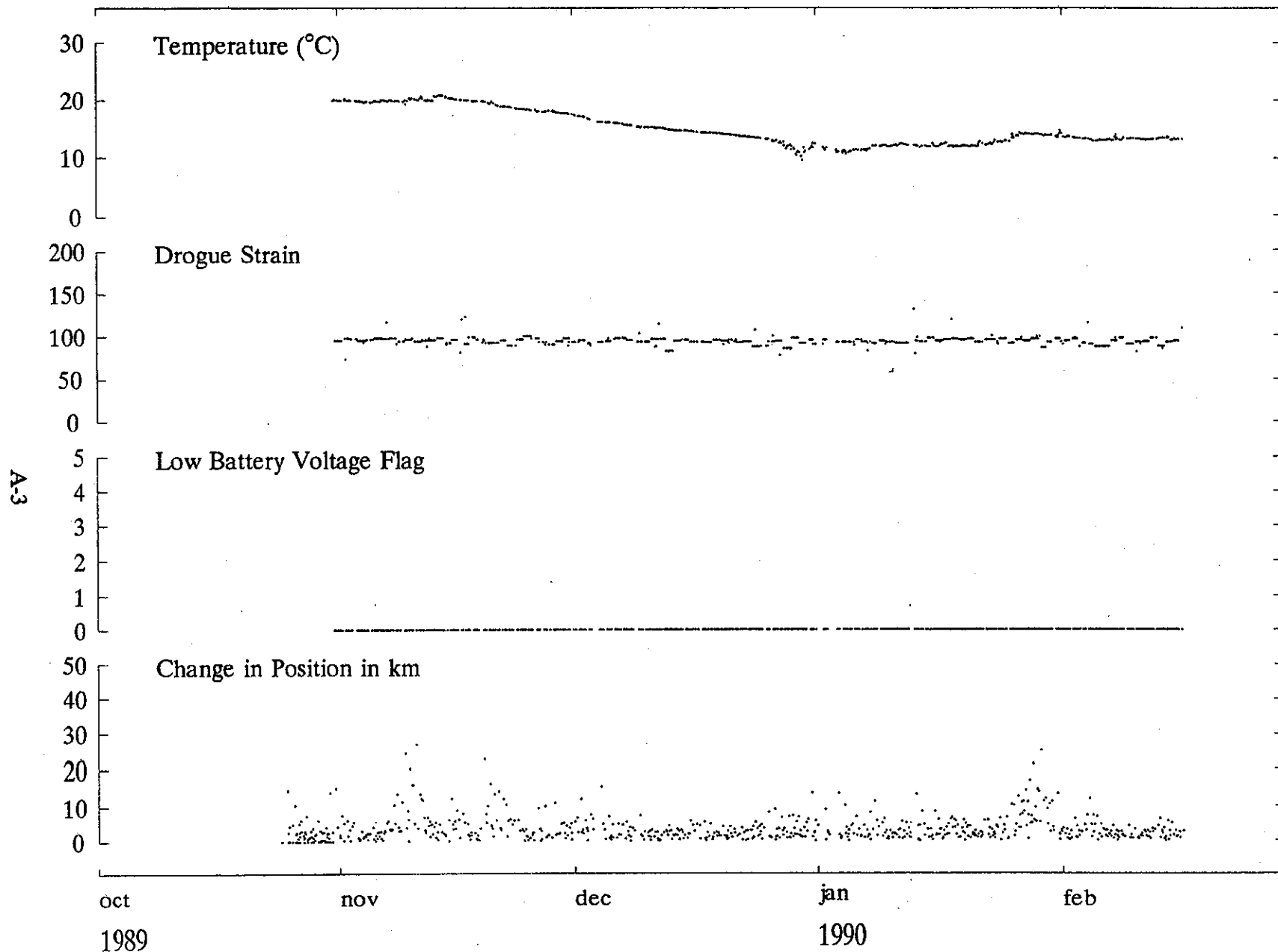


Figure A-1(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09320.

The data have been quality-assured, removing transmission errors and wild points.

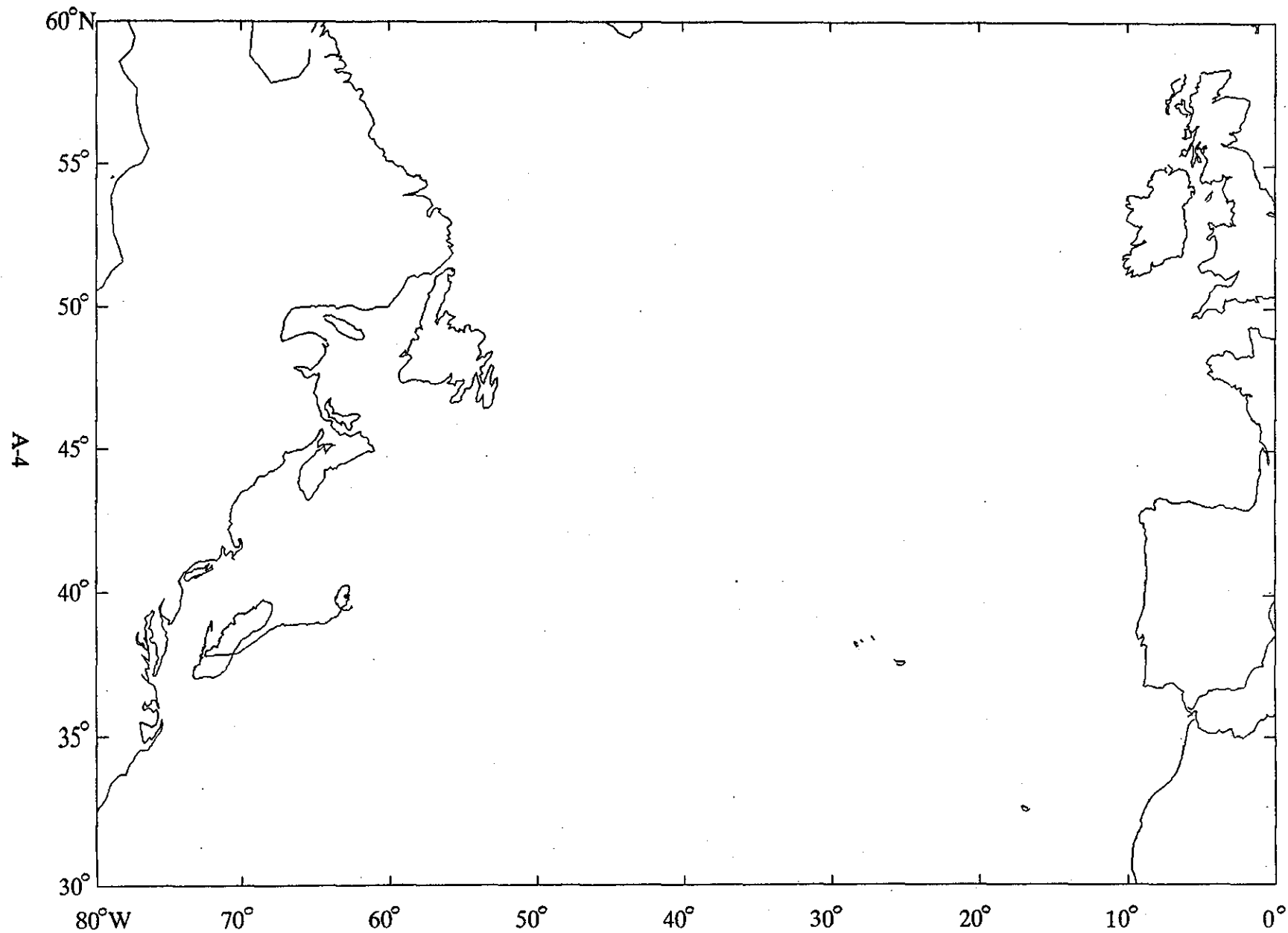
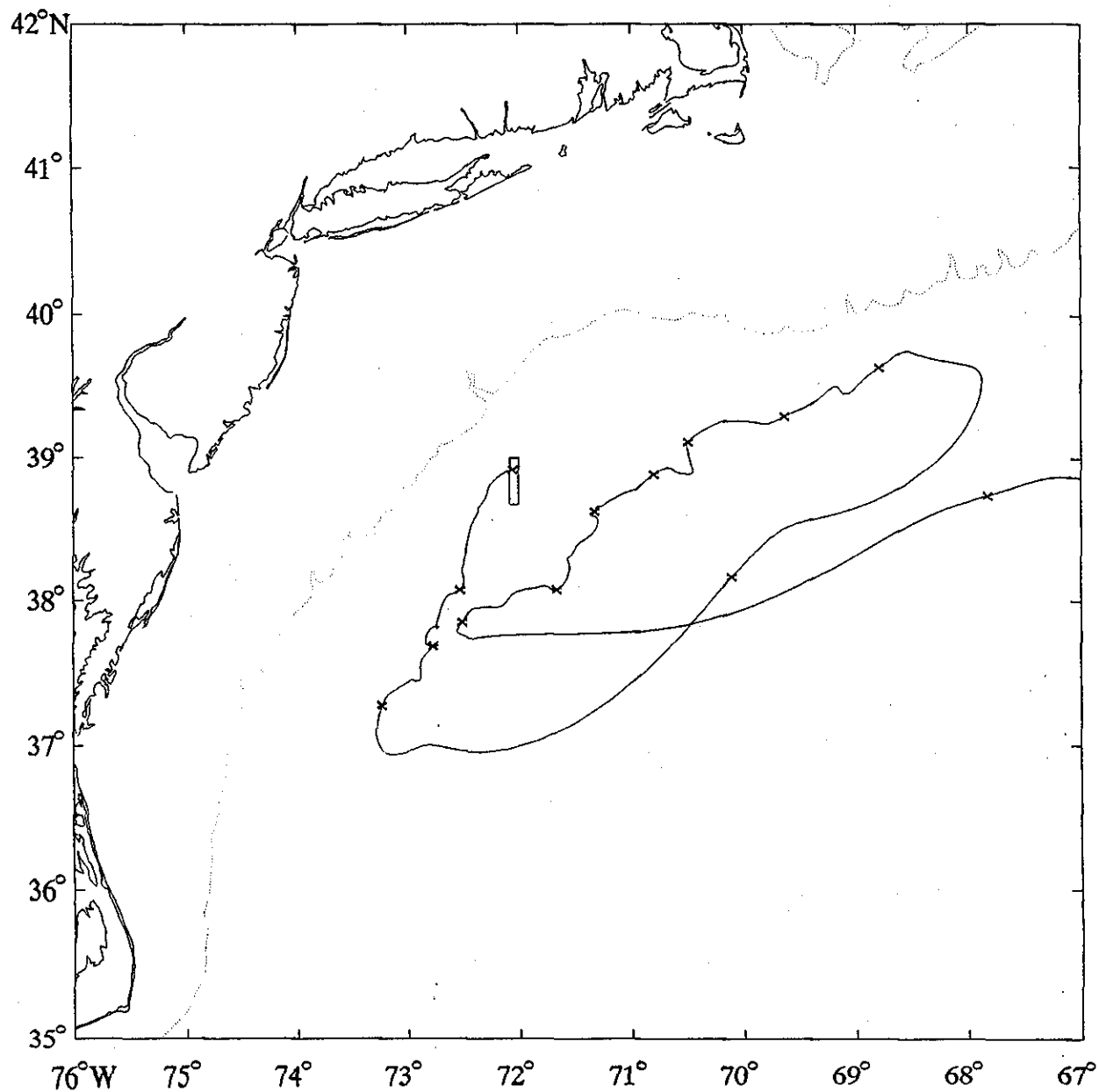


Figure A-2(a). Trajectory of Drifter Number 09321 Deployed on October 26, 1989.

The last transmission was on February 17, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-2(b). Trajectory of Drifter Number 09321 Deployed on October 26, 1989,
Shown in the Vicinity of the Middle Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day Low-pass filter.

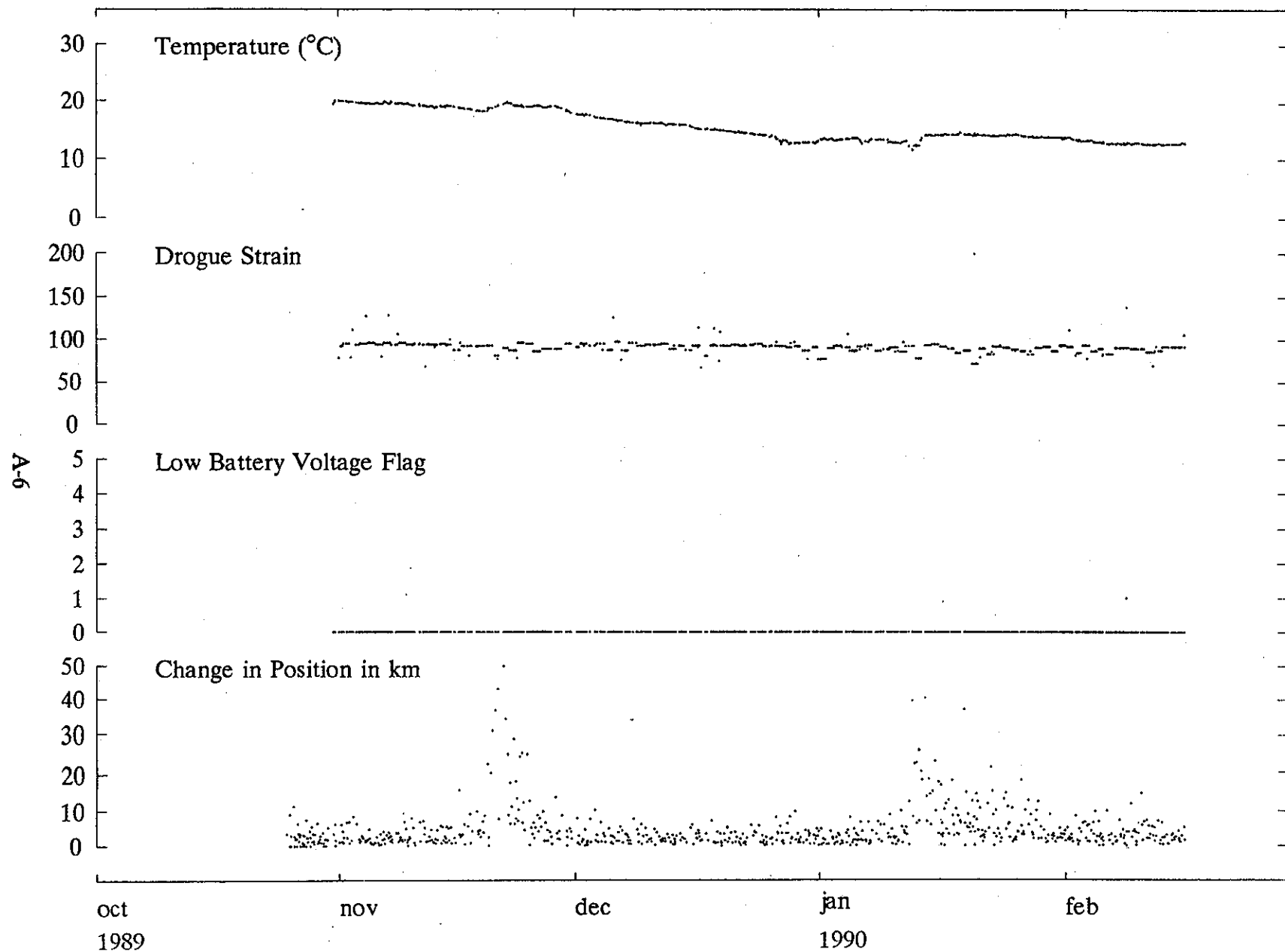


Figure A-2(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09321.

The data have been quality-assured, removing transmission errors and wild points.

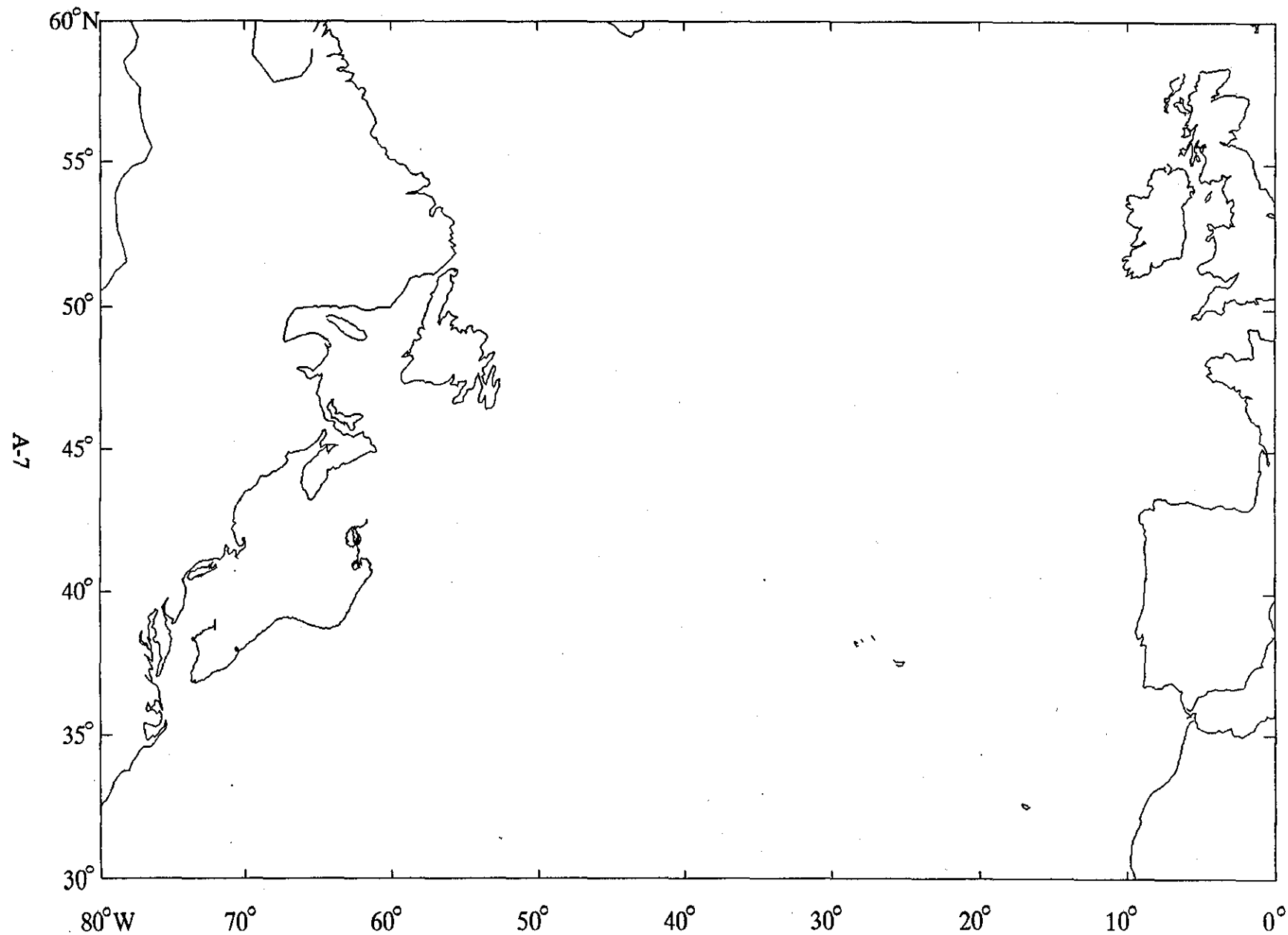
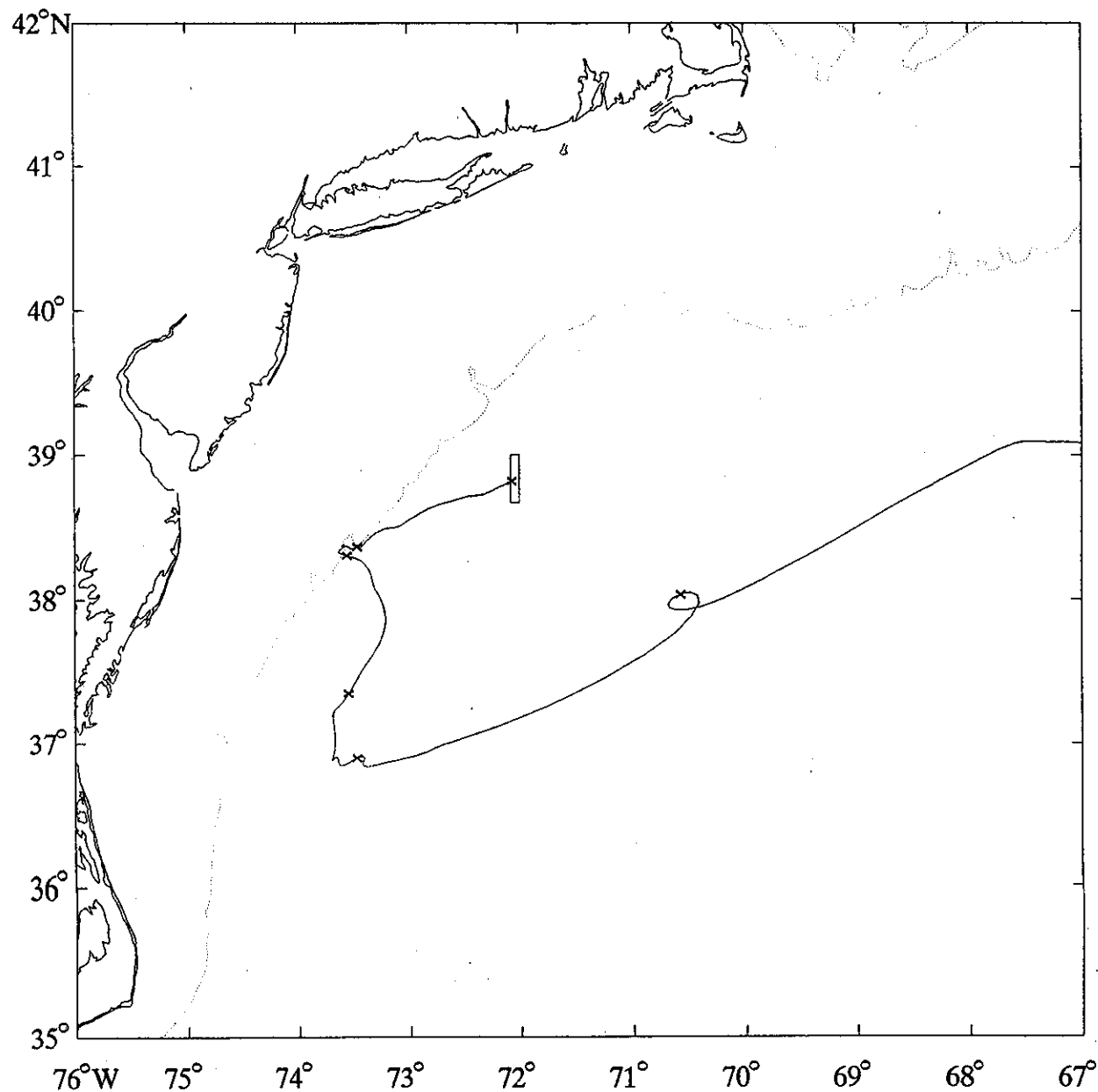


Figure A-3(a). Trajectory of Drifter Number 09322 Deployed on October 29, 1989.

The last transmission was on February 17, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-3(b). Trajectory of Drifter Number 09322 Deployed on October 29, 1989,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

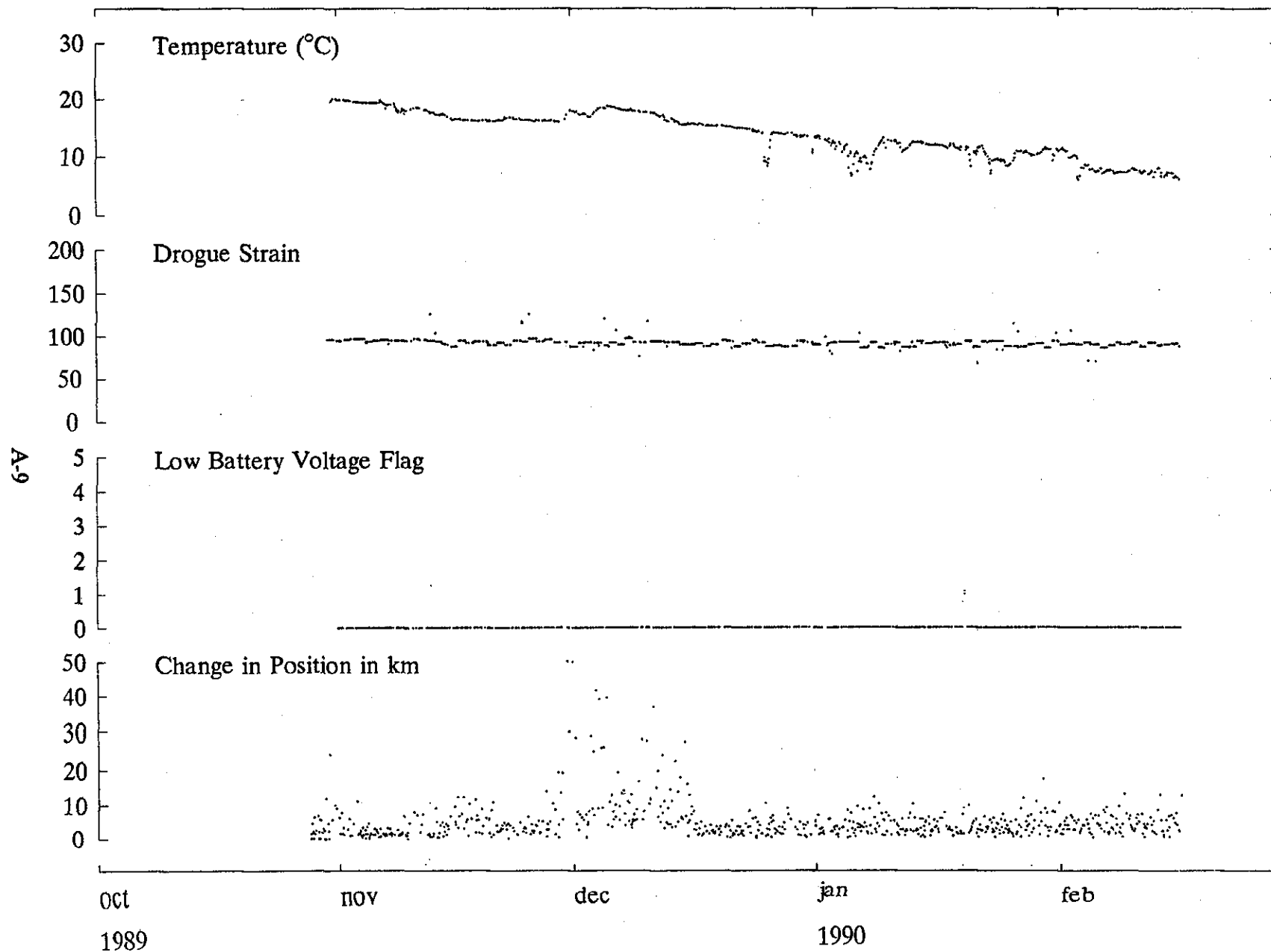


Figure A-3(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09322.

The data have been quality-assured, removing transmission errors and wild points.

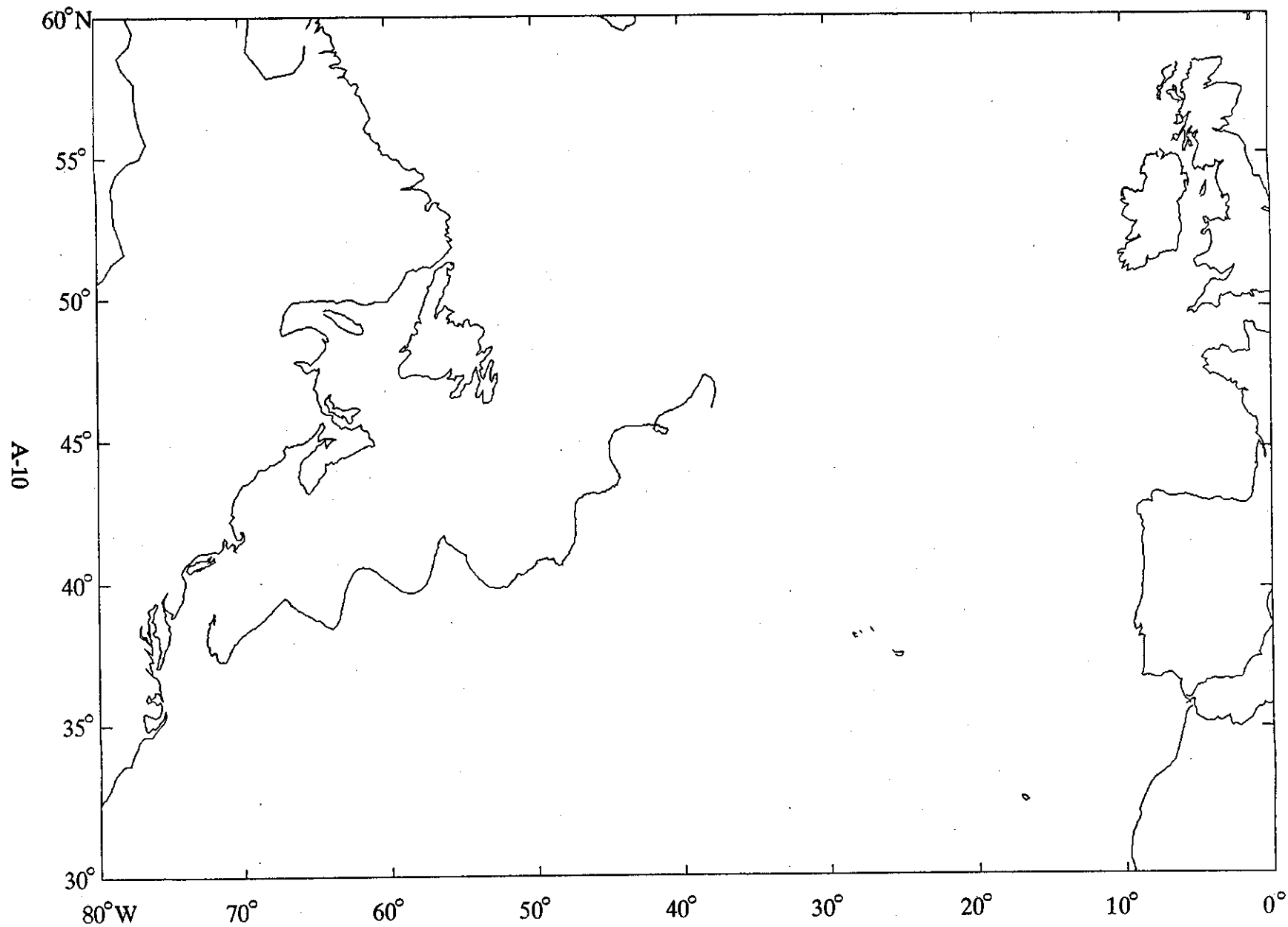
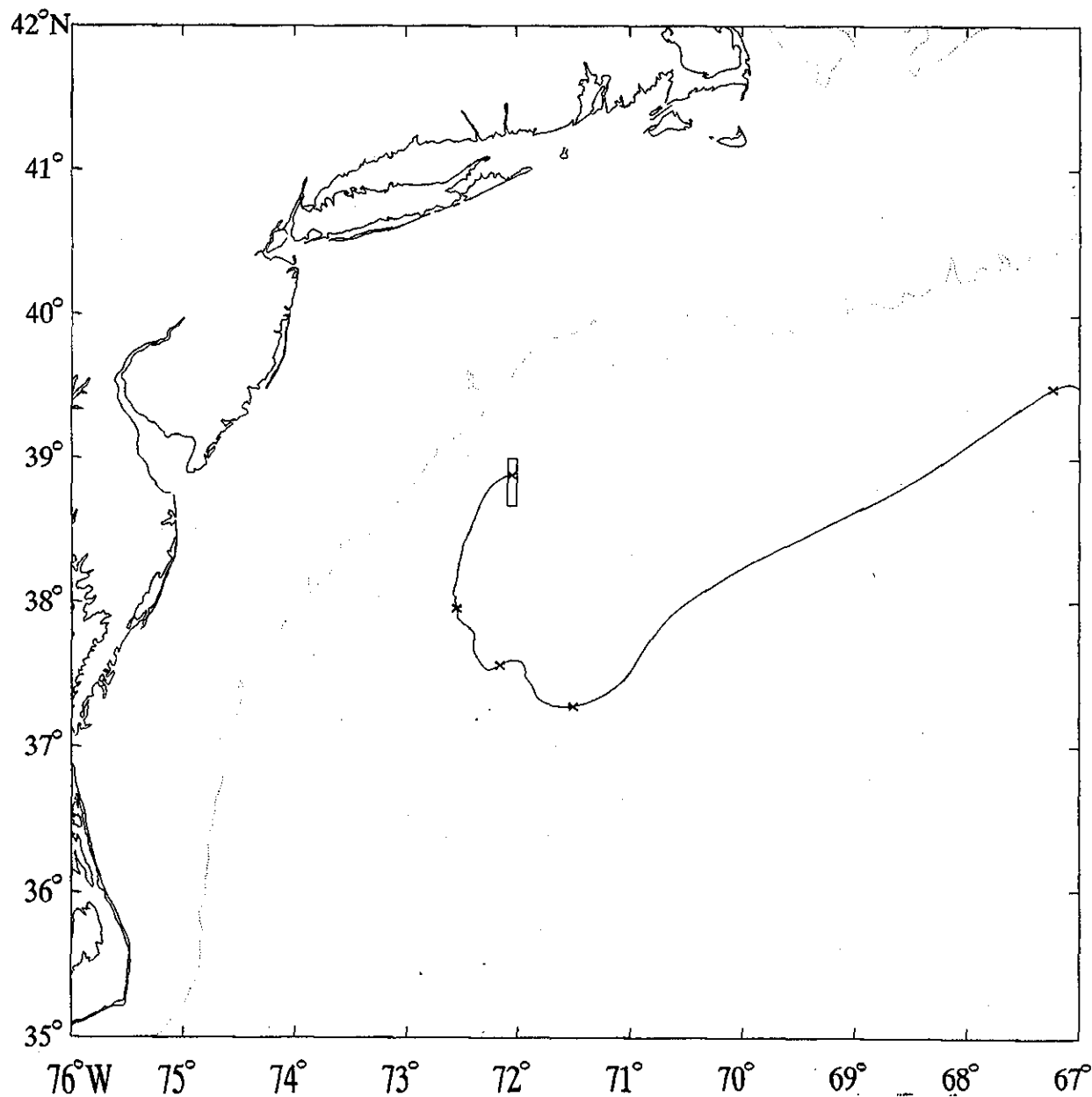


Figure A-4(a). Trajectory of Drifter Number 09323 Deployed on October 31, 1989.

The last transmission was on February 17, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-4(b). Trajectory of Drifter Number 09323 Deployed on October 31, 1989,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.
Crosses are evenly spaced at 7-day intervals.

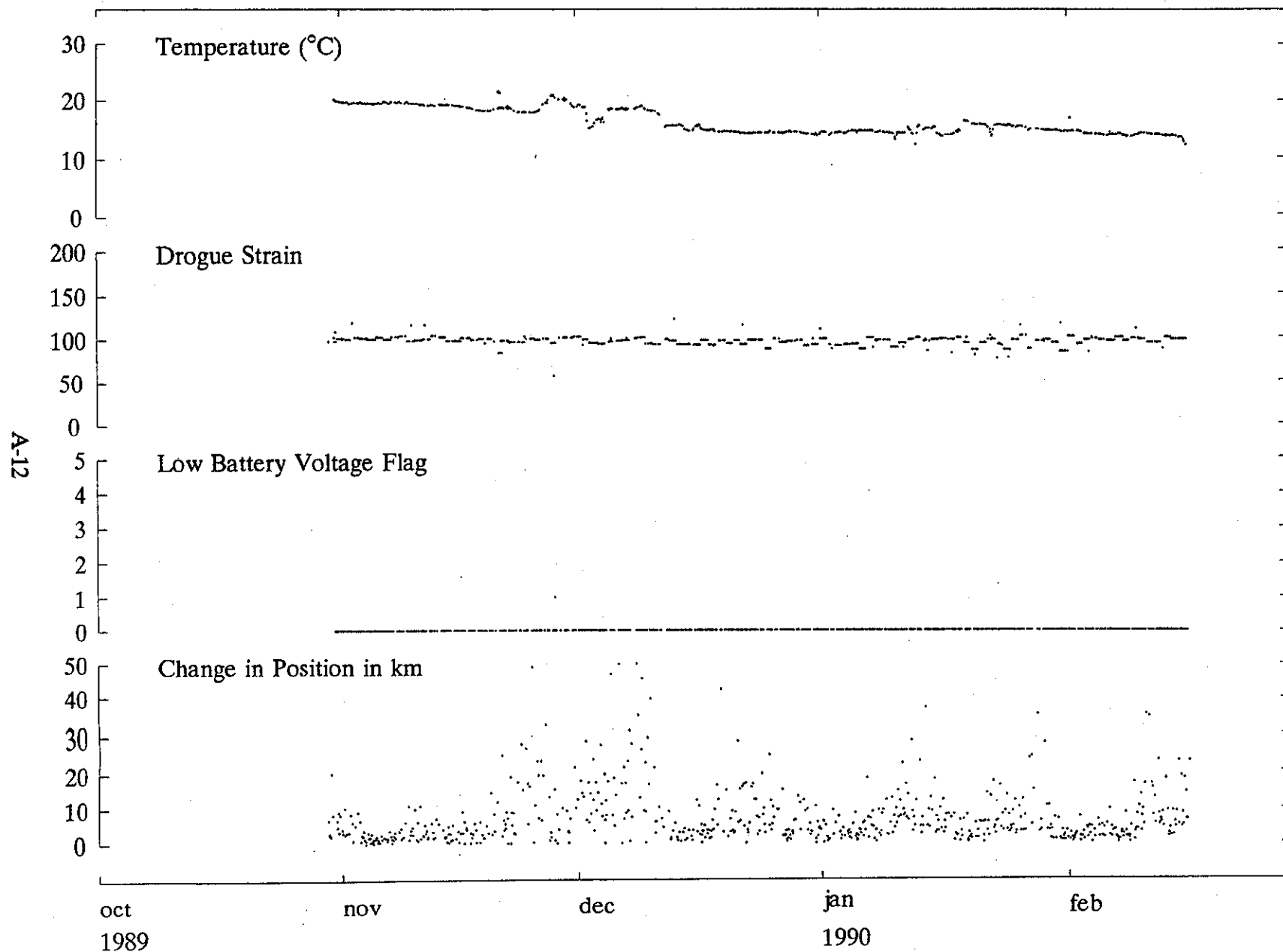


Figure A-4(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09323.

The data have been quality-assured, removing transmission errors and wild points.

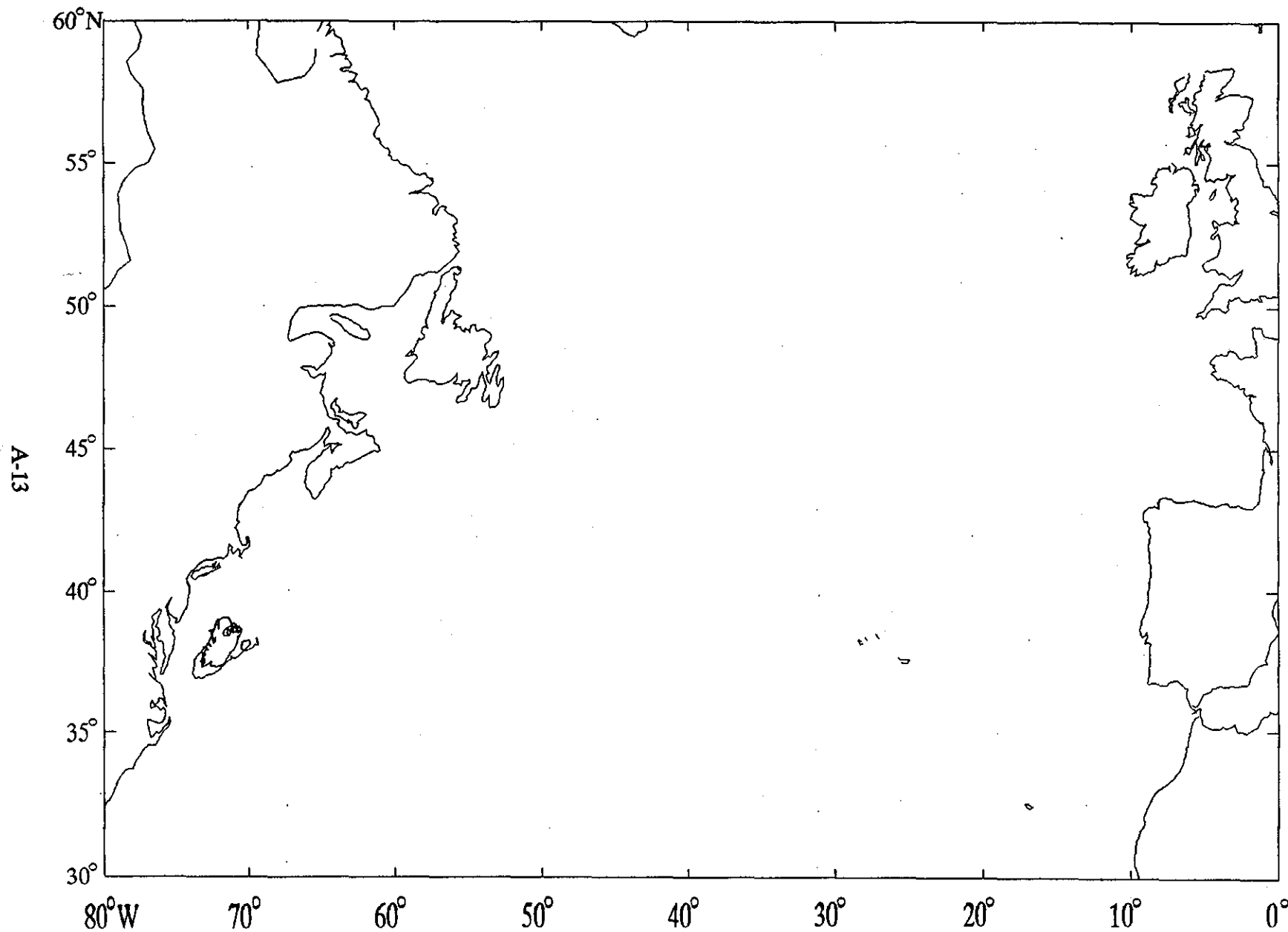
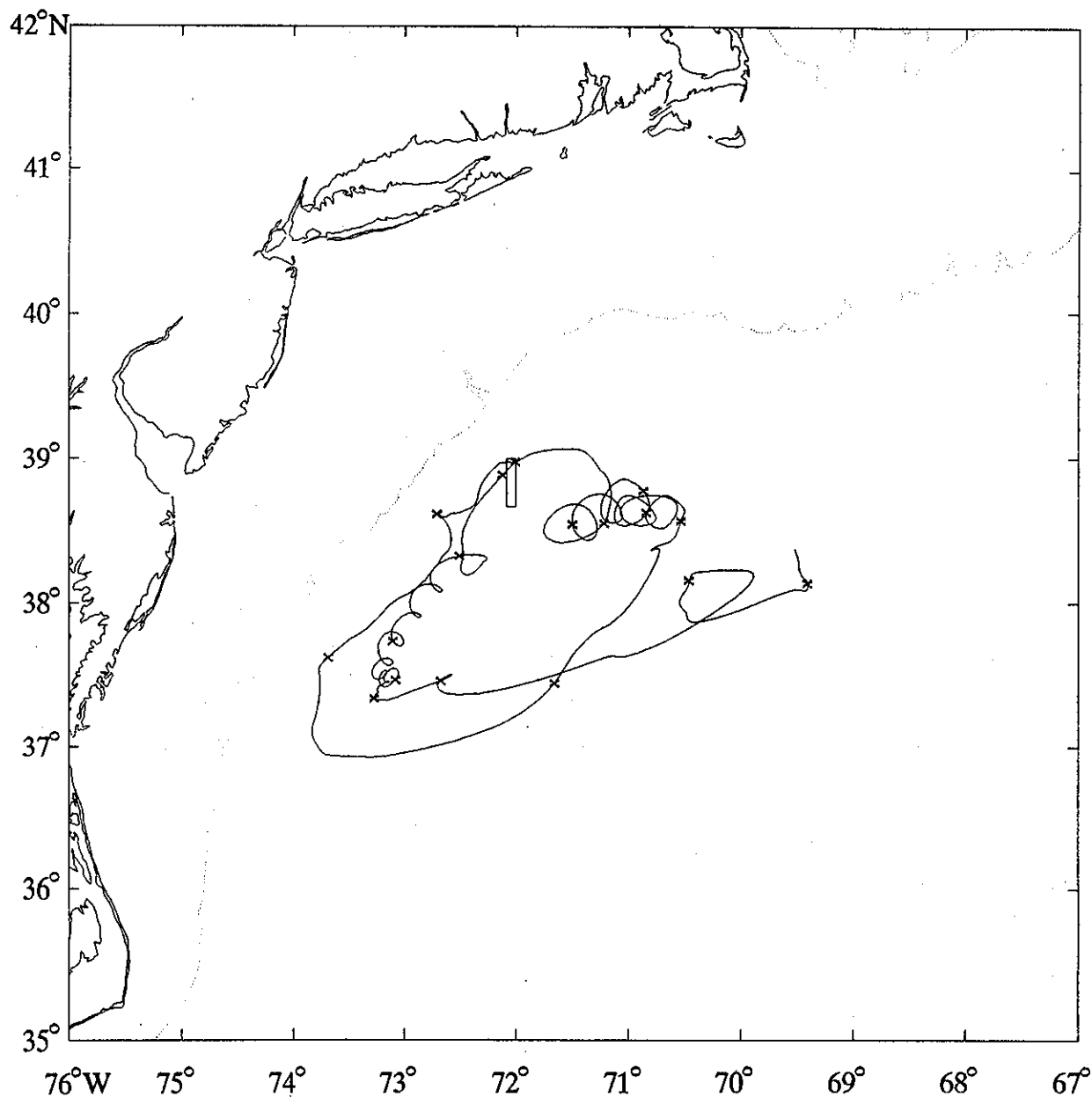


Figure A-5(a). Trajectory of Drifter Number 09324 Deployed on January 11, 1990.

The last transmission was on May 6, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-5(b). Trajectory of Drifter Number 09324 Deployed on January 11, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-15

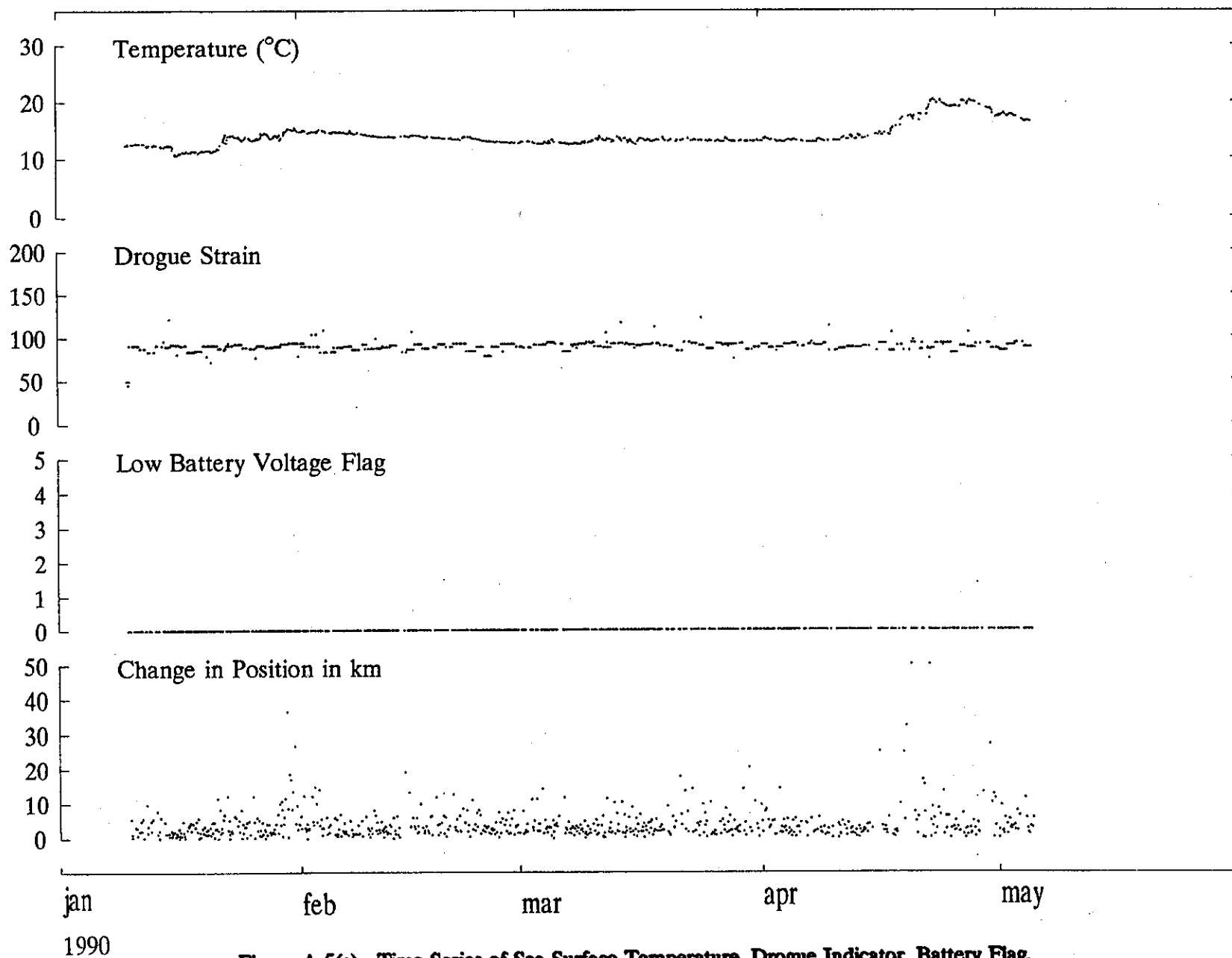


Figure A-5(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09324.

The data have been quality-assured, removing transmission errors and wild points.

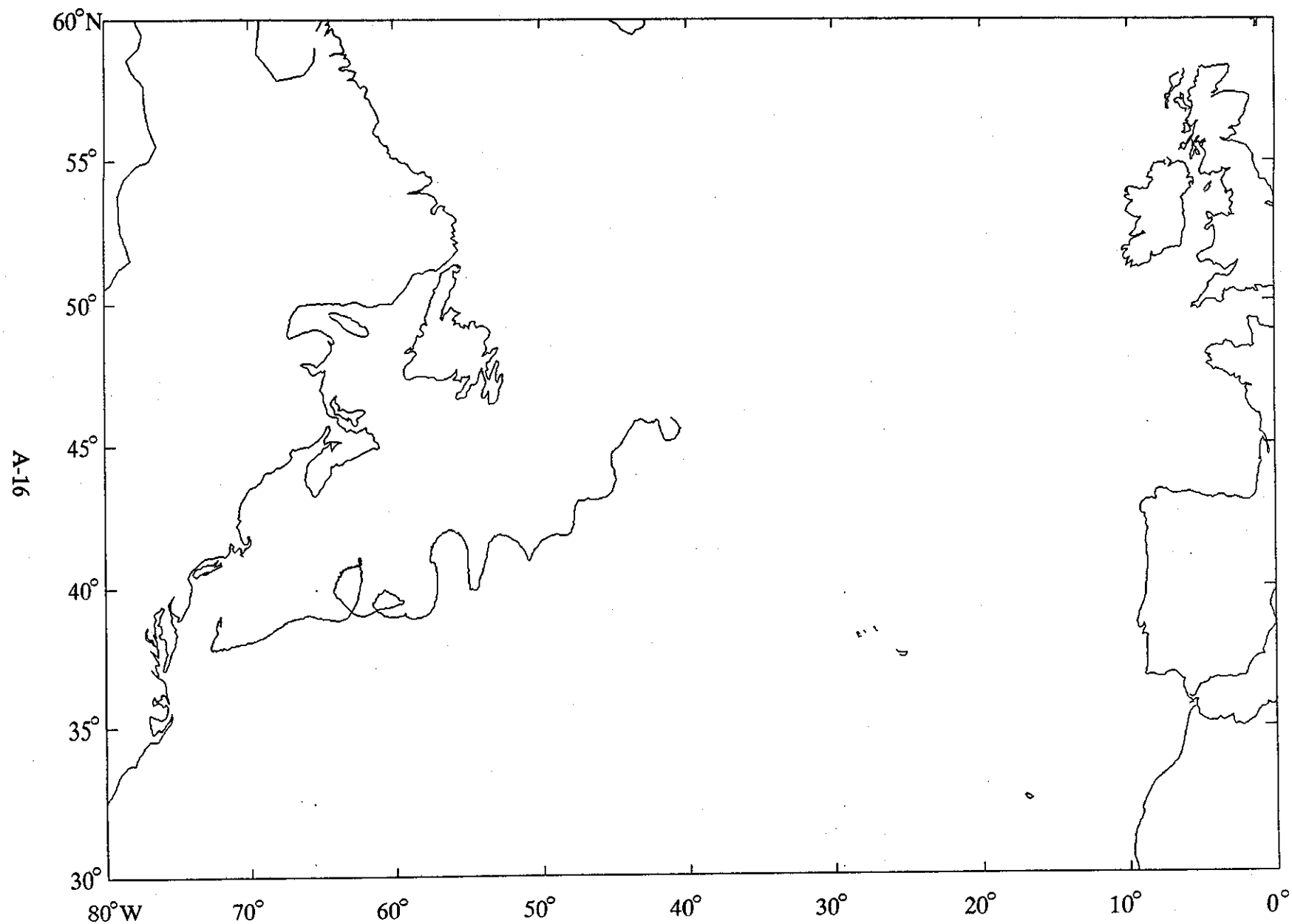
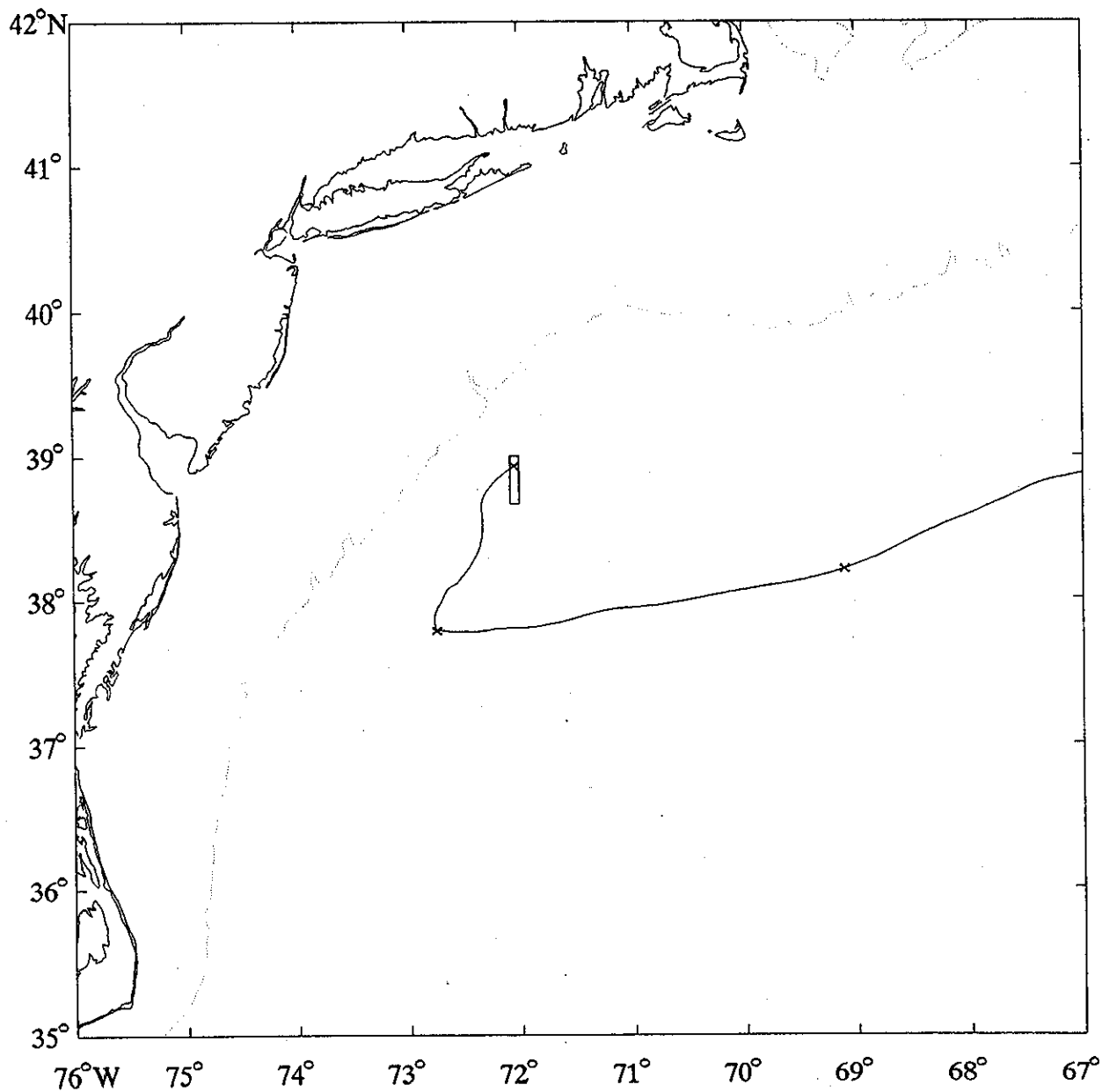


Figure A-6(a). Trajectory of Drifter Number 09325 Deployed on December 30, 1989.

The last transmission was on May 1, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-6(b). Trajectory of Drifter Number 09325 Deployed on December 30, 1989,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

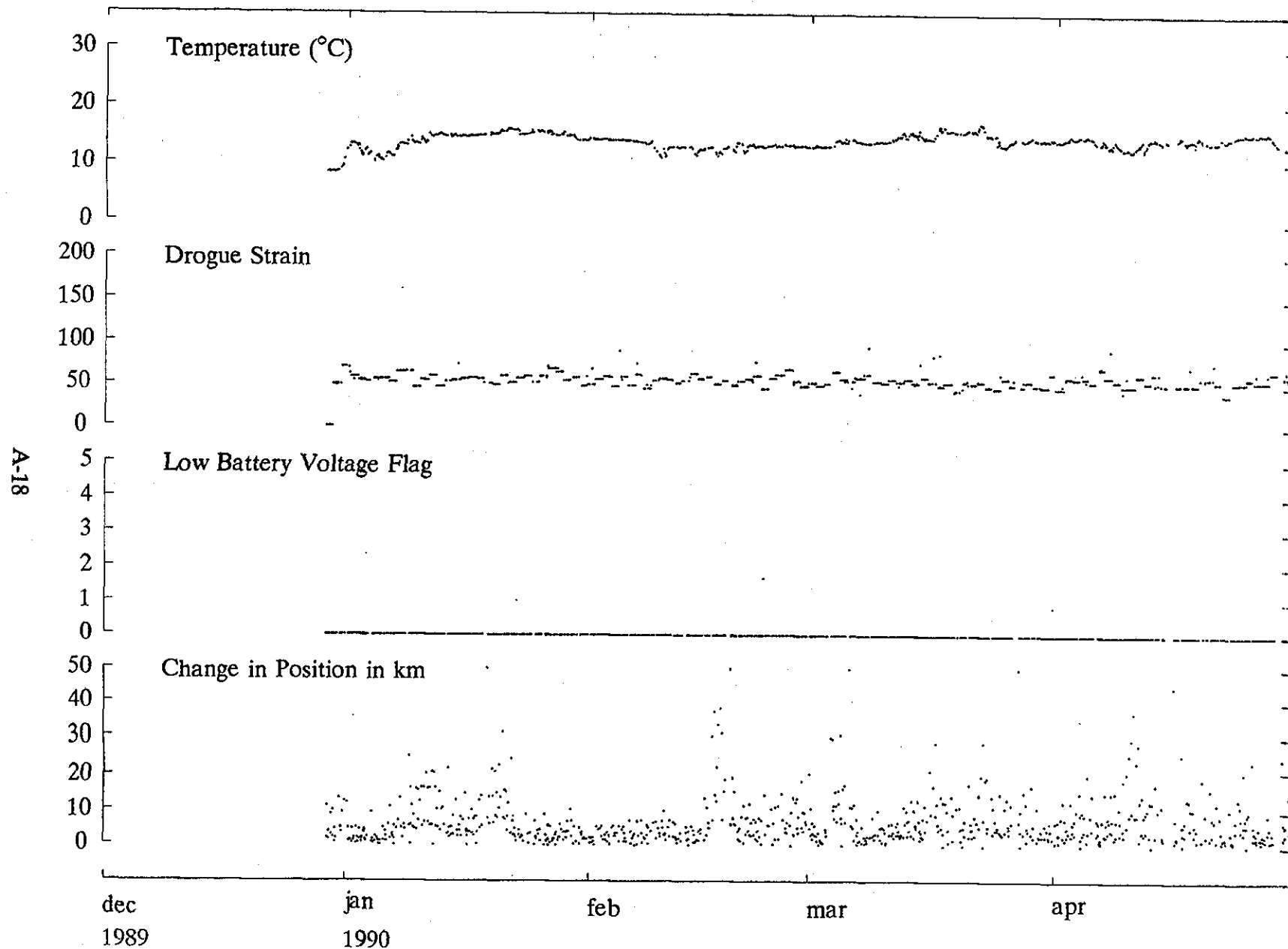


Figure A-6(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09325.

The data have been quality-assured, removing transmission errors and wild points.

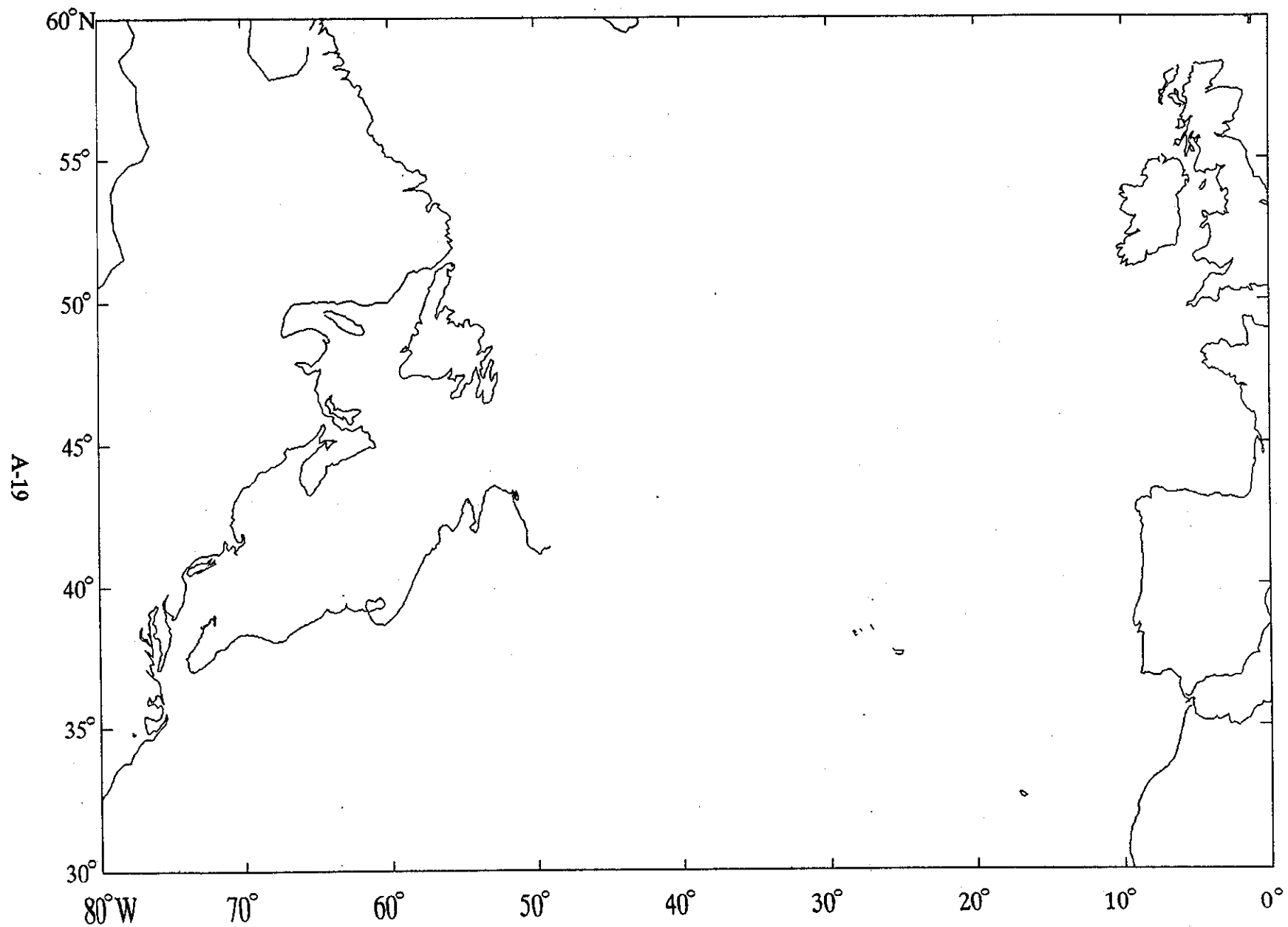
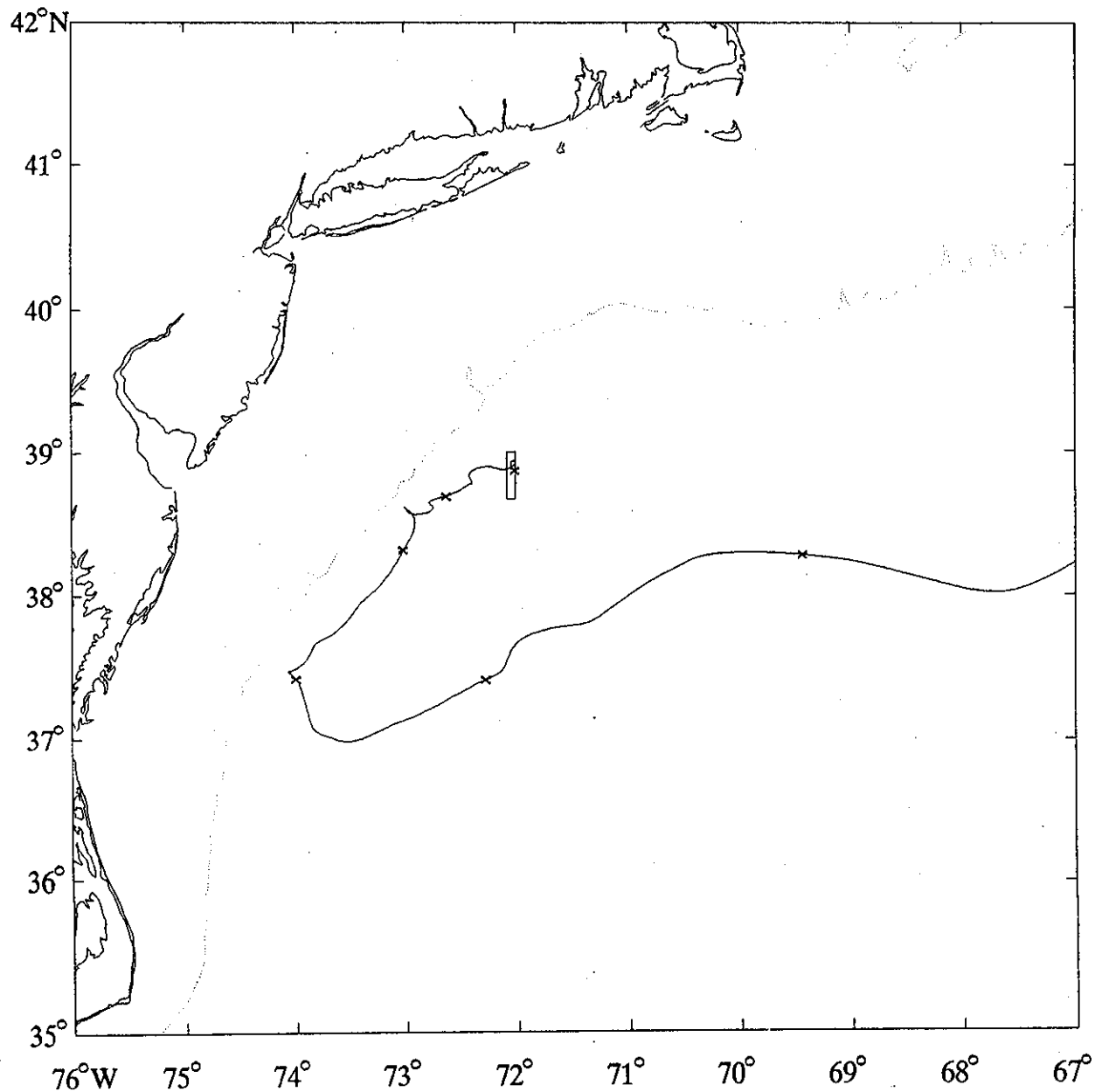


Figure A-7(a). Trajectory of Drifter Number 09326 Deployed on January 17, 1990.

The last transmission was on May 20, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-7(b). Trajectory of Drifter Number 09326 Deployed on January 17, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-21

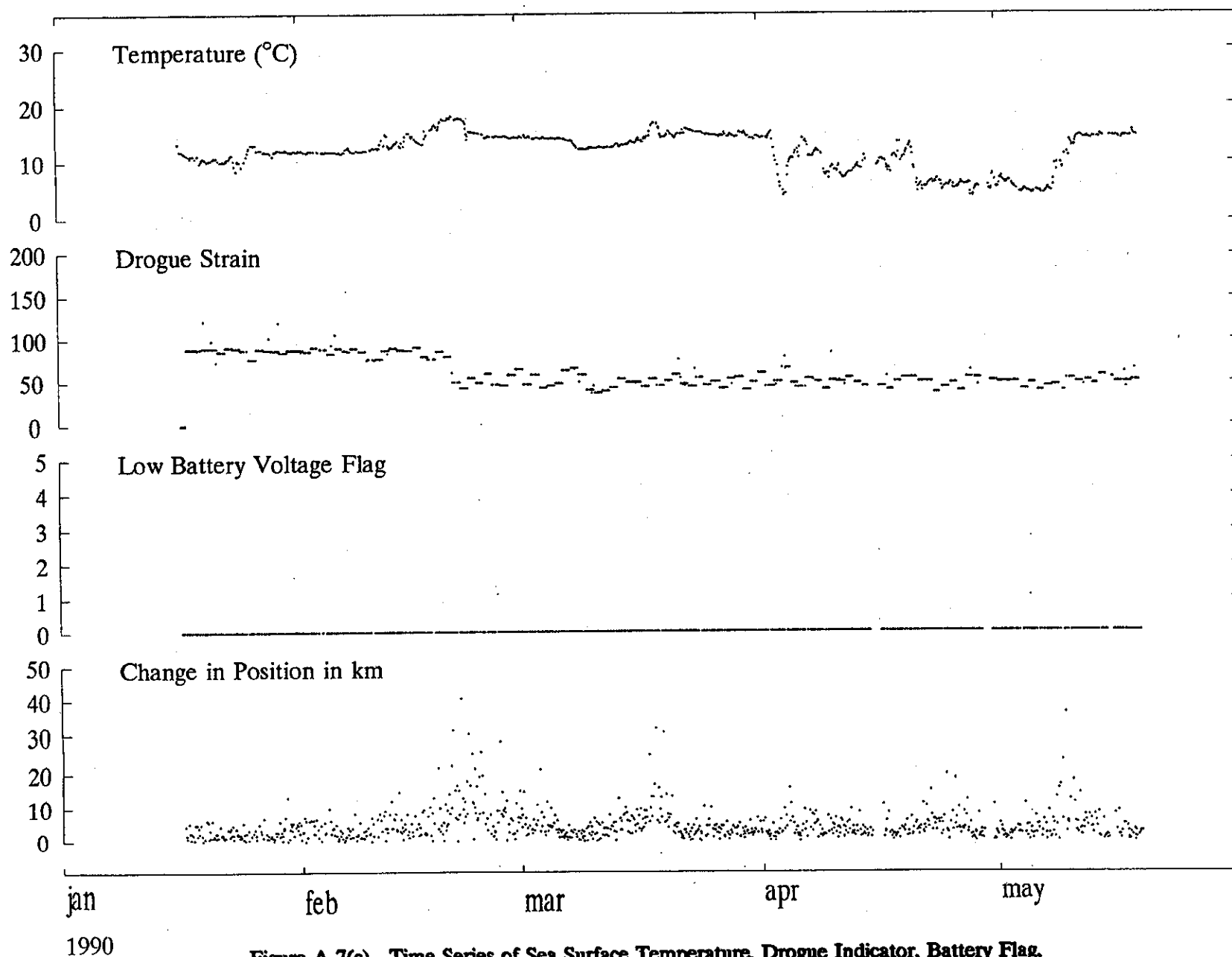


Figure A-7(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09326.

The data have been quality-assured, removing transmission errors and wild points.

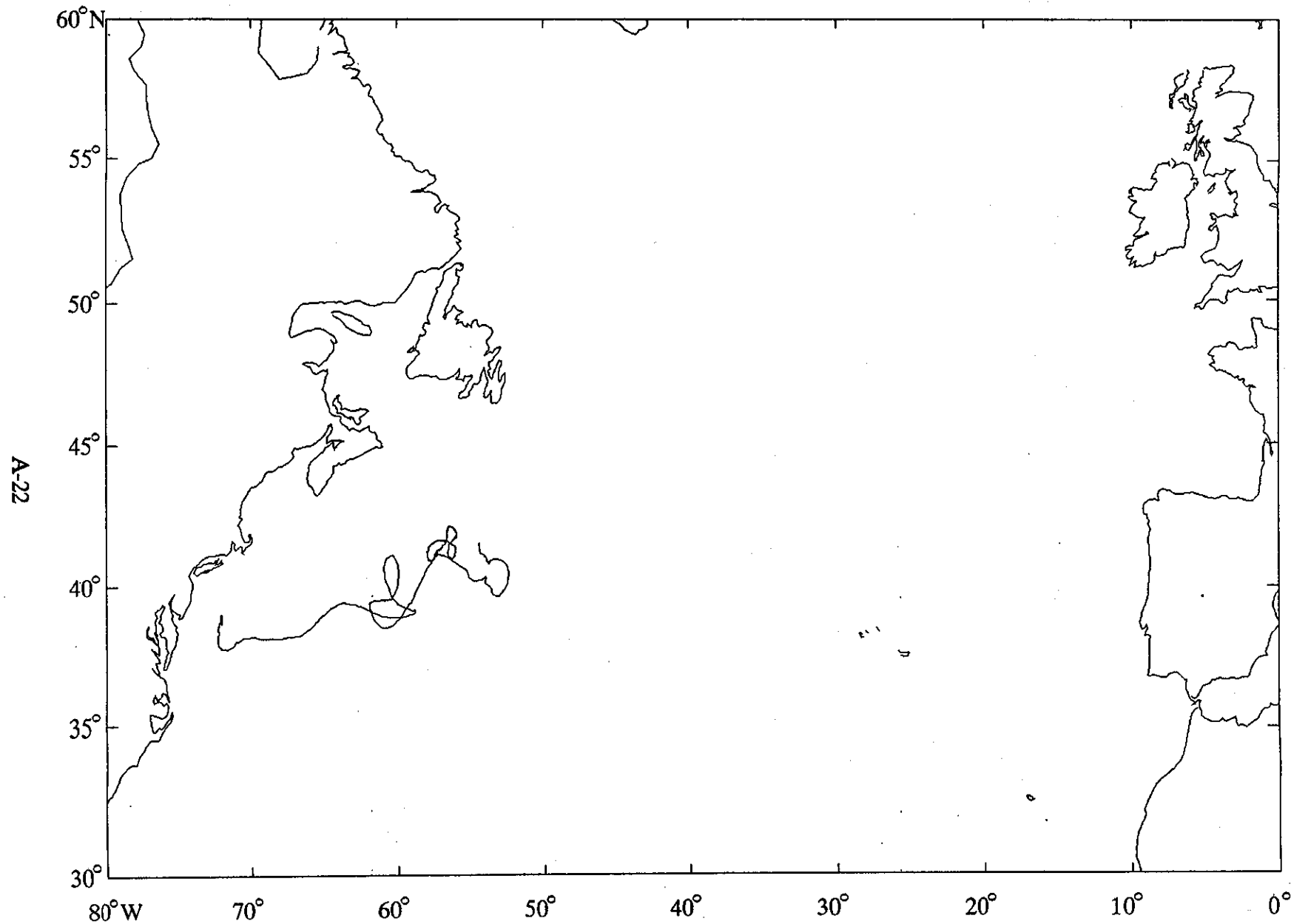
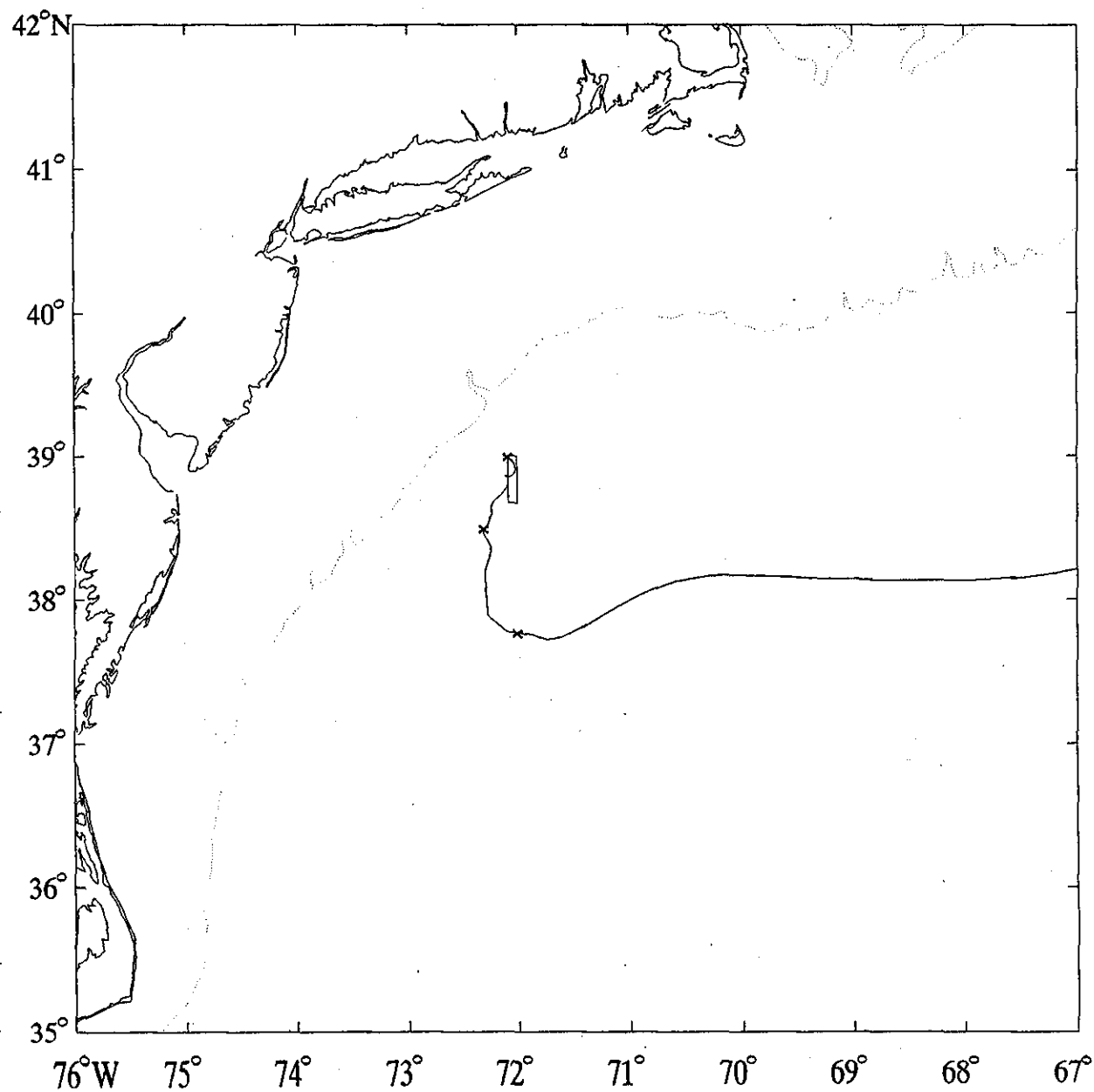


Figure A-8(a). Trajectory of Drifter Number 09327 Deployed on February 2, 1990.

The last transmission was on May 28, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-8(b). Trajectory of Drifter Number 09327 Deployed on February 2, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-24

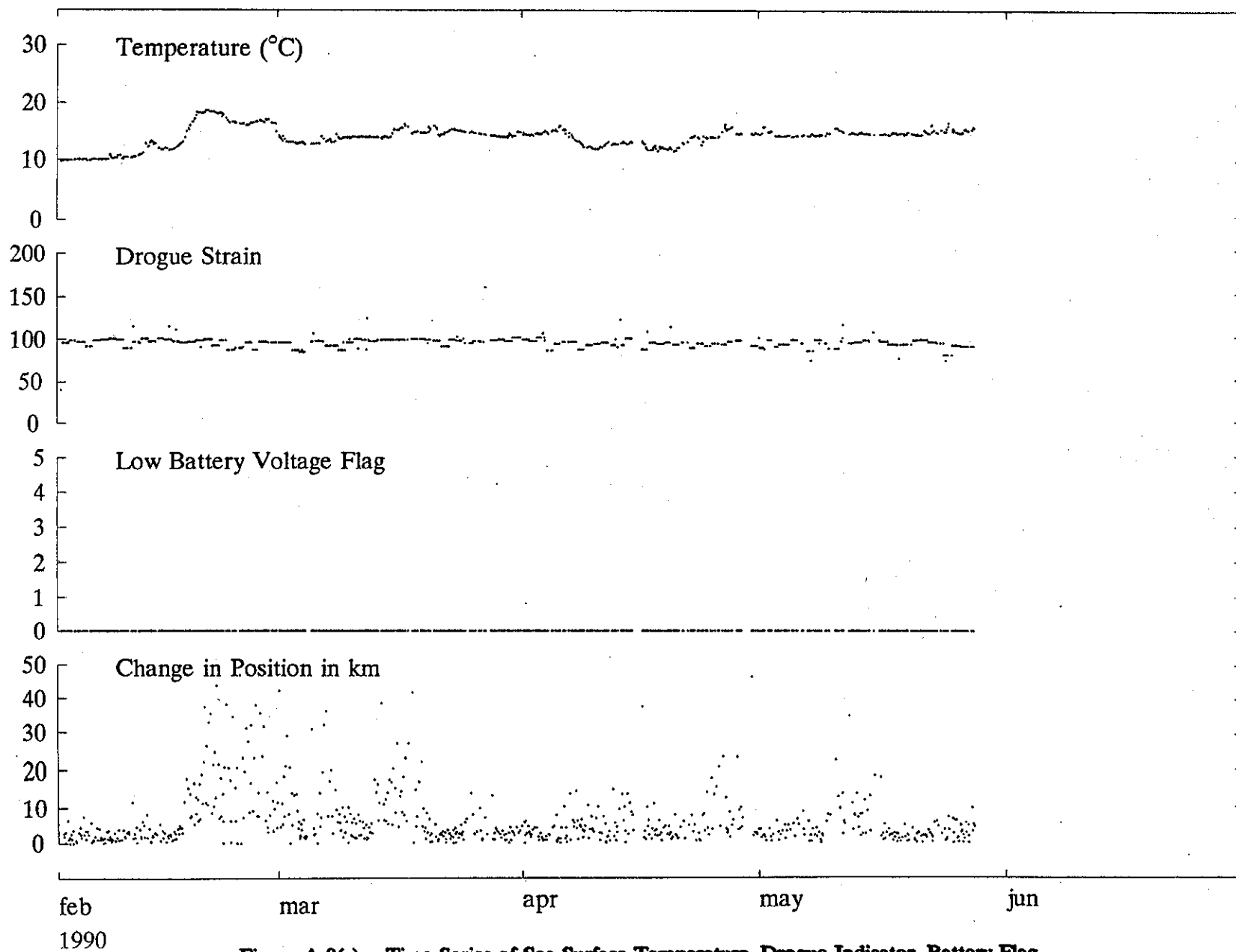


Figure A-8(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09327.

The data have been quality-assured, removing transmission errors and wild points.

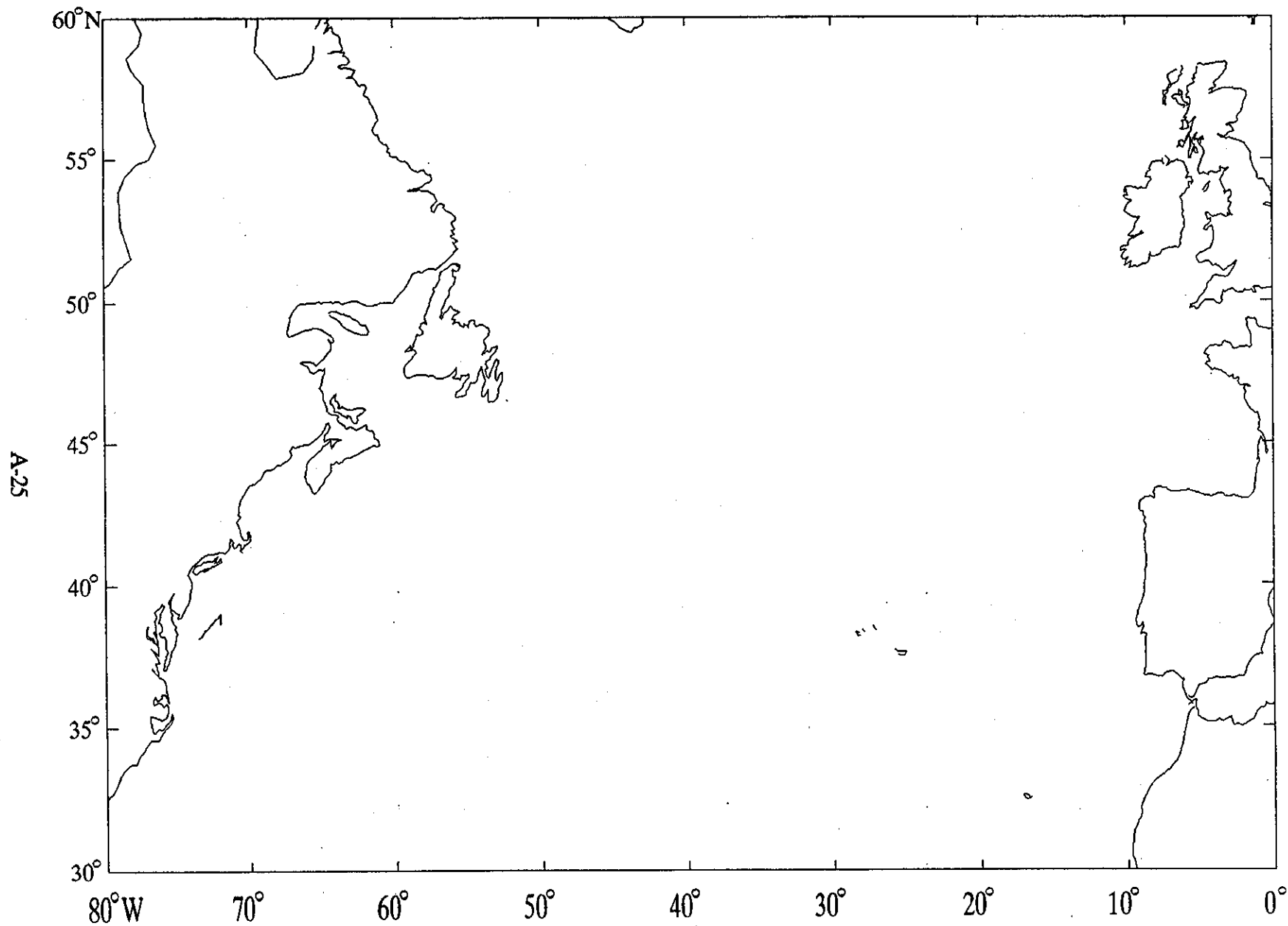
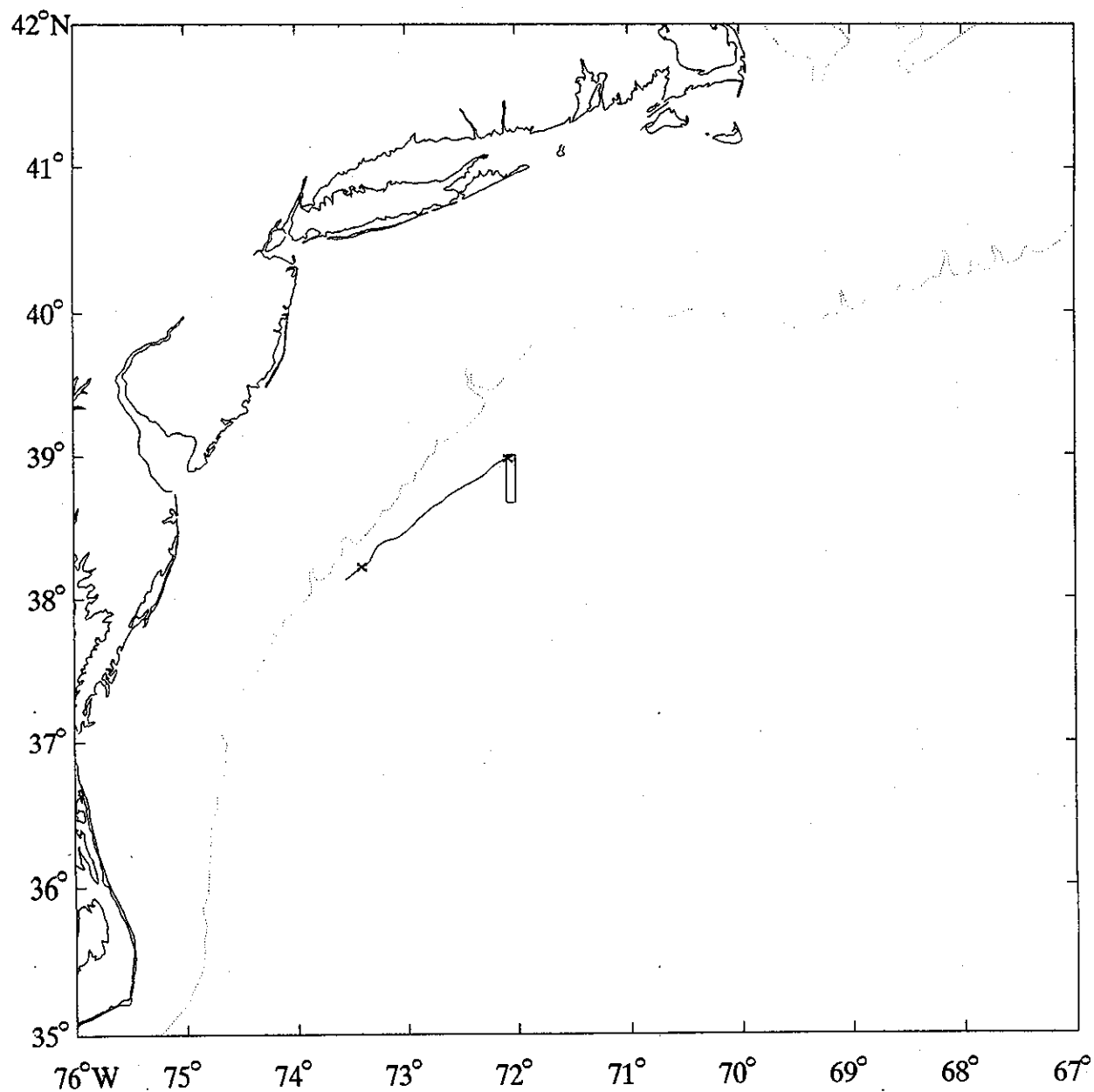


Figure A-9(a). Trajectory of Drifter Number 09328 Deployed on March 3, 1990.

The last transmission was on March 11, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-9(b). Trajectory of Drifter Number 09328 Deployed on March 3, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-27

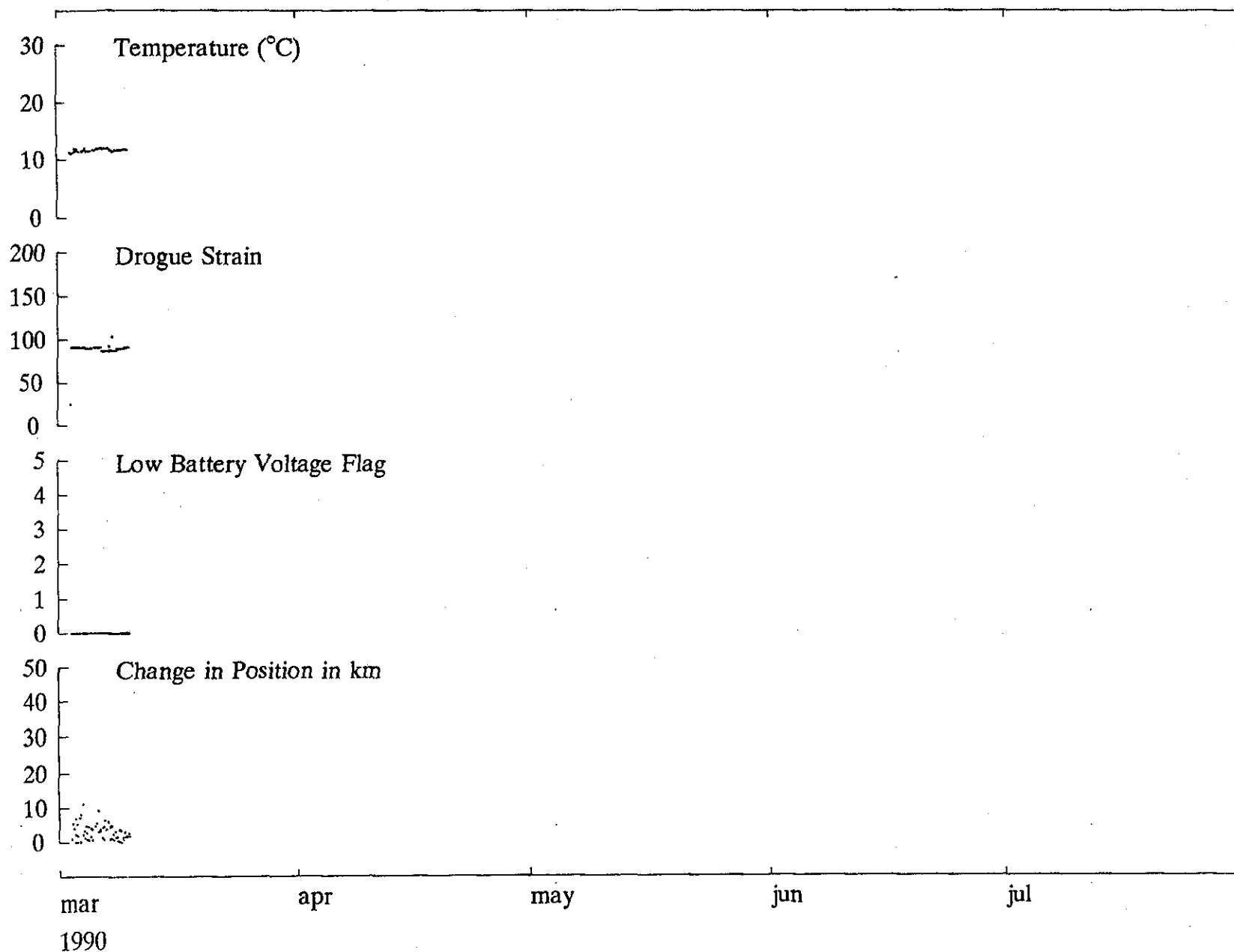


Figure A-9(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09328.

The data have been quality-assured, removing transmission errors and wild points.

A-30

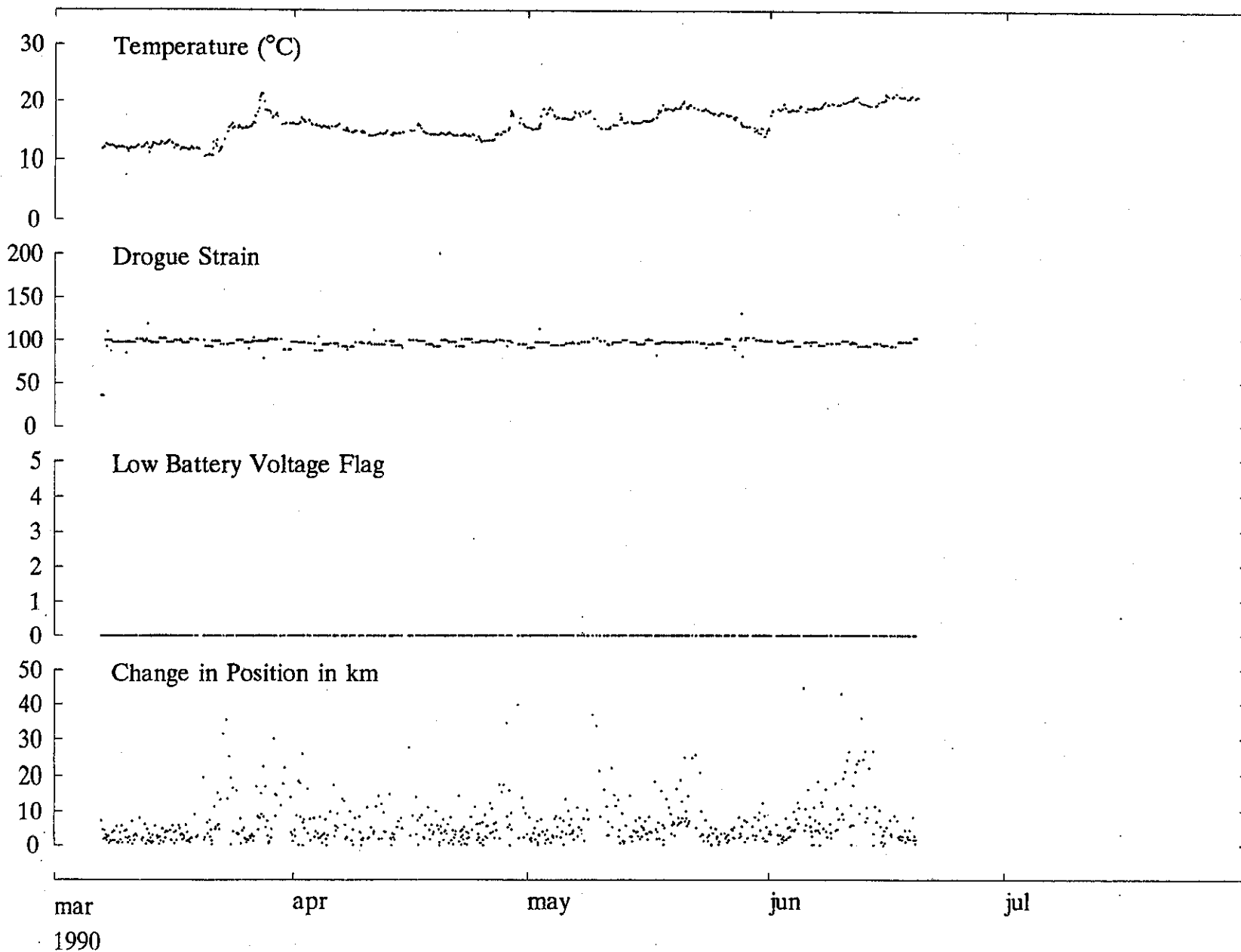


Figure A-10(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 09329.

The data have been quality-assured, removing transmission errors and wild points.

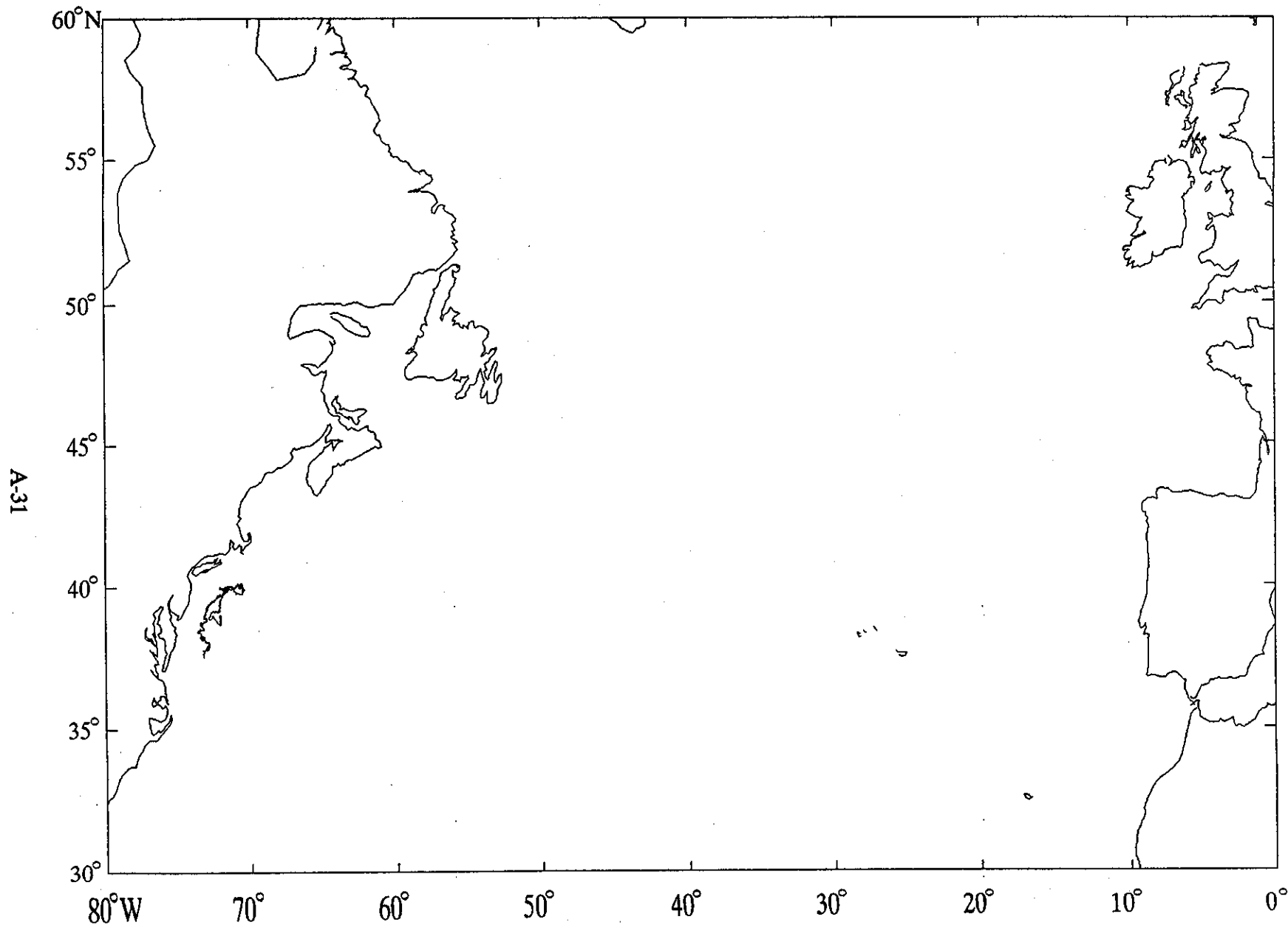


Figure A-11(a). Trajectory of Drifter Number 12730 Deployed on April 13, 1990.

The last transmission was on August 1, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.

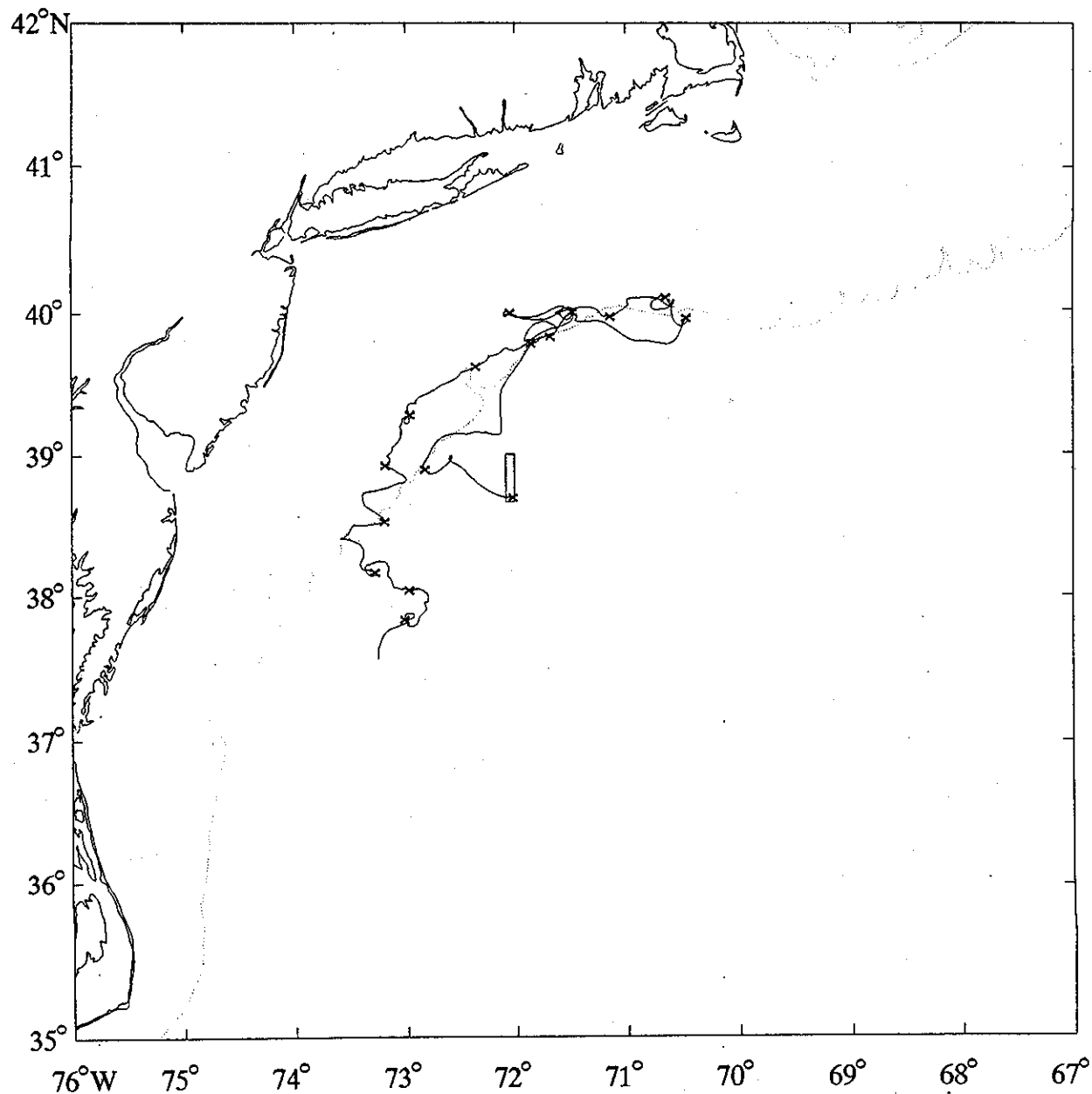


Figure A-11(b). Trajectory of Drifter Number 12730 Deployed on April 13, 1990, Shown in the Vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-33

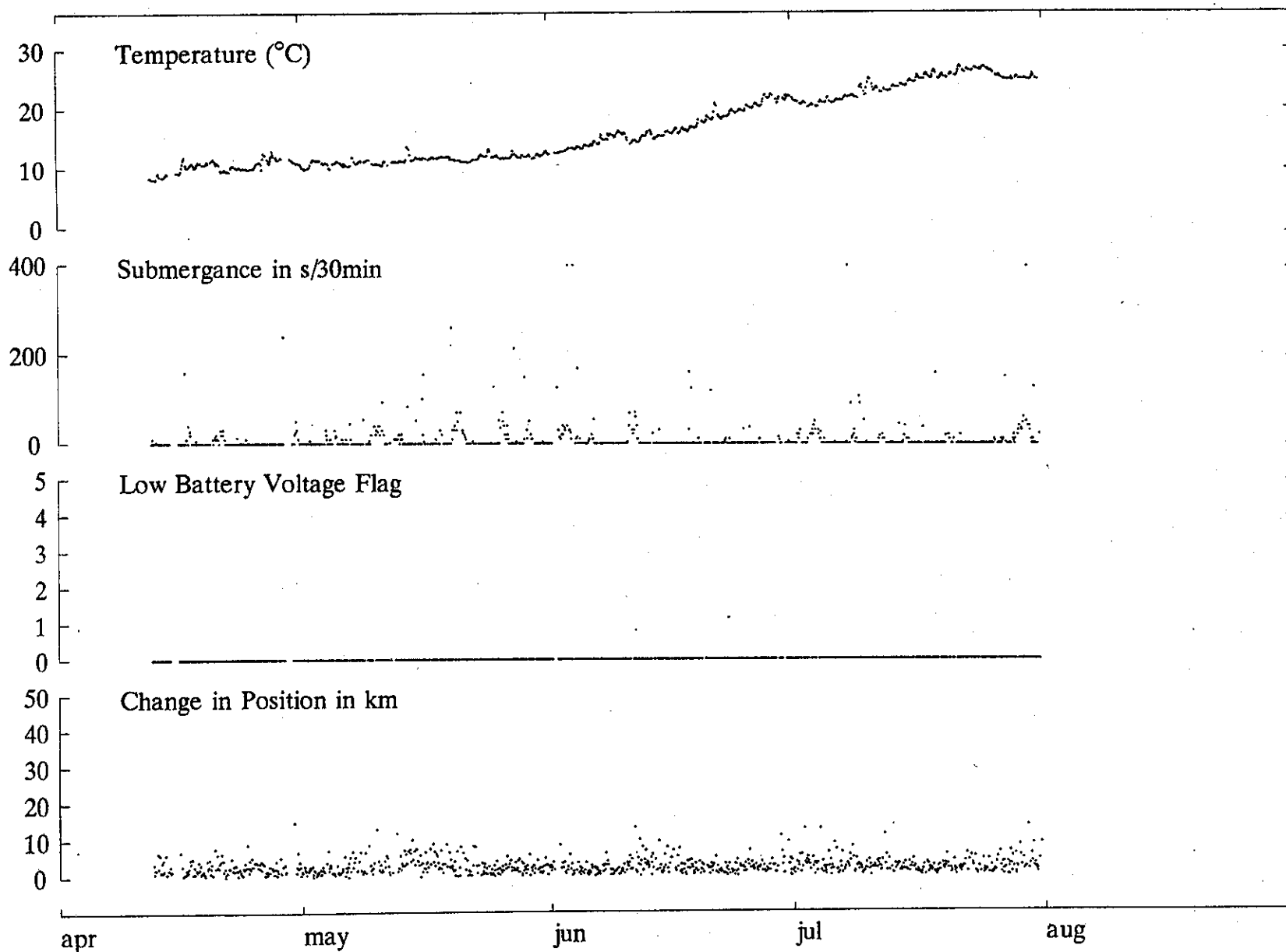


Figure A-11(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12730.

The data have been quality-assured, removing transmission errors and wild points.

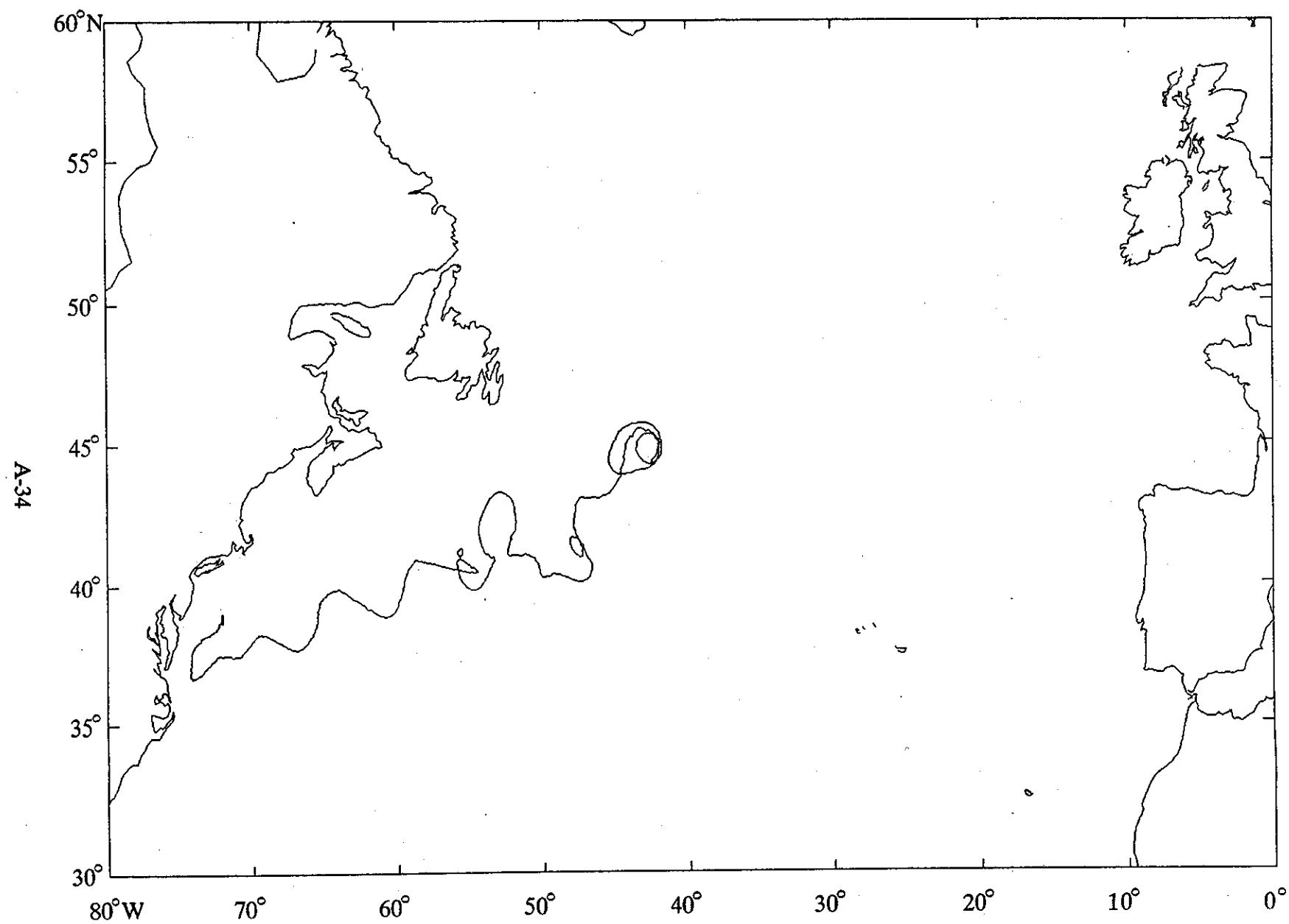


Figure A-12(a). Trajectory of Drifter Number 12731 Deployed on March 24, 1990.

The last transmission was on July 24, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.

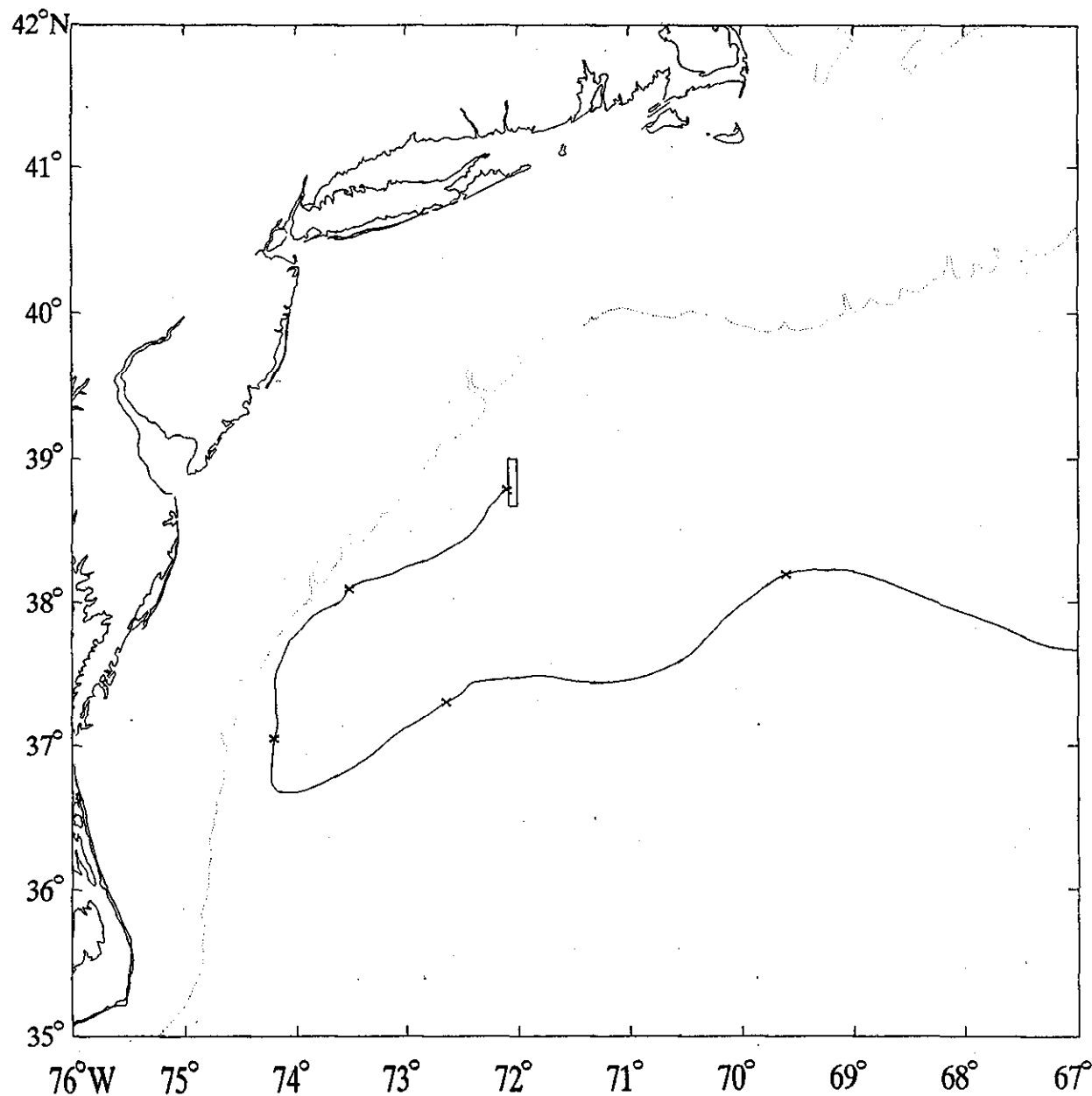


Figure A-12(b). Trajectory of Drifter Number 12731 Deployed on March 24, 1990, Shown in the Vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-36

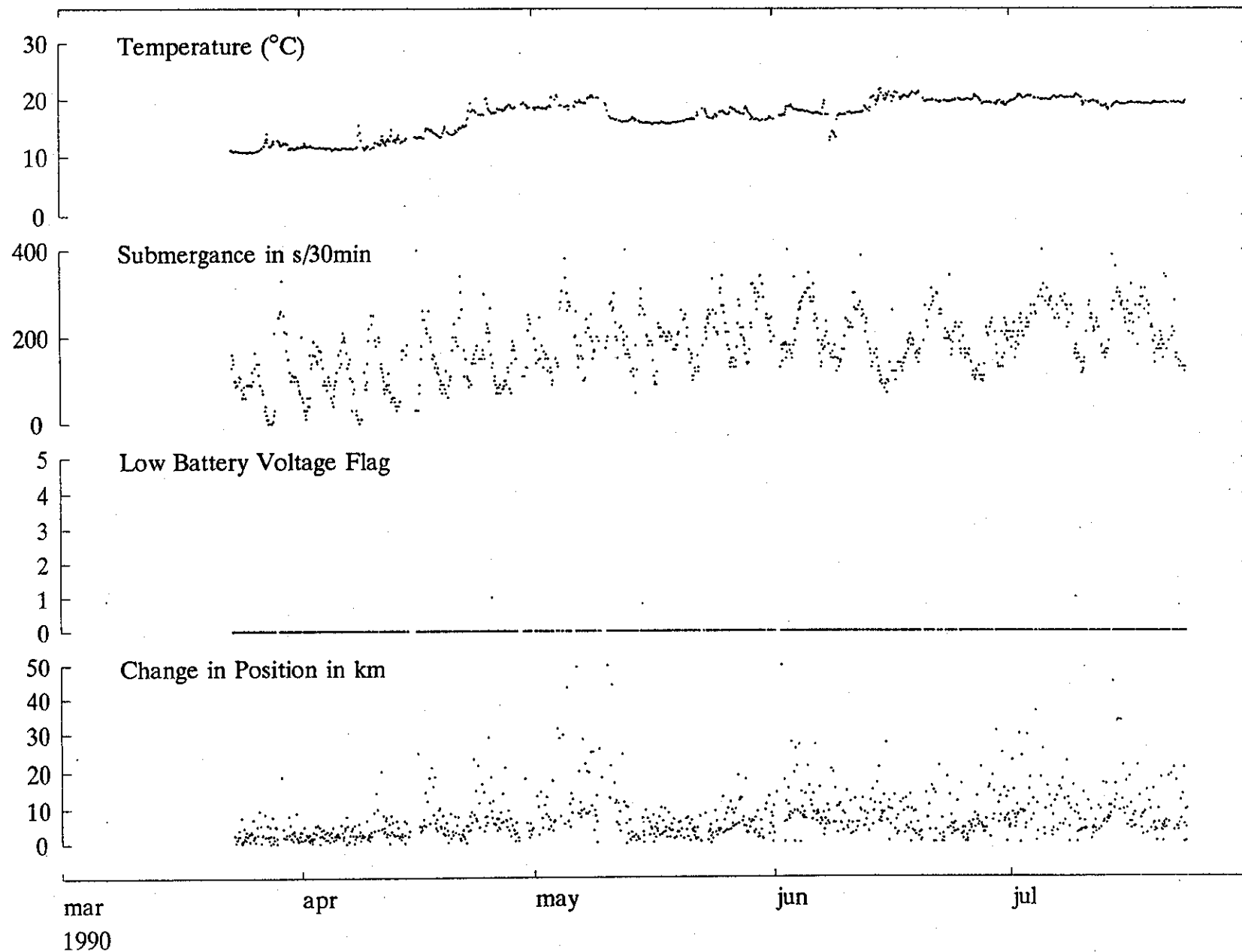


Figure A-12(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12731.

The data have been quality-assured, removing transmission errors and wild points.

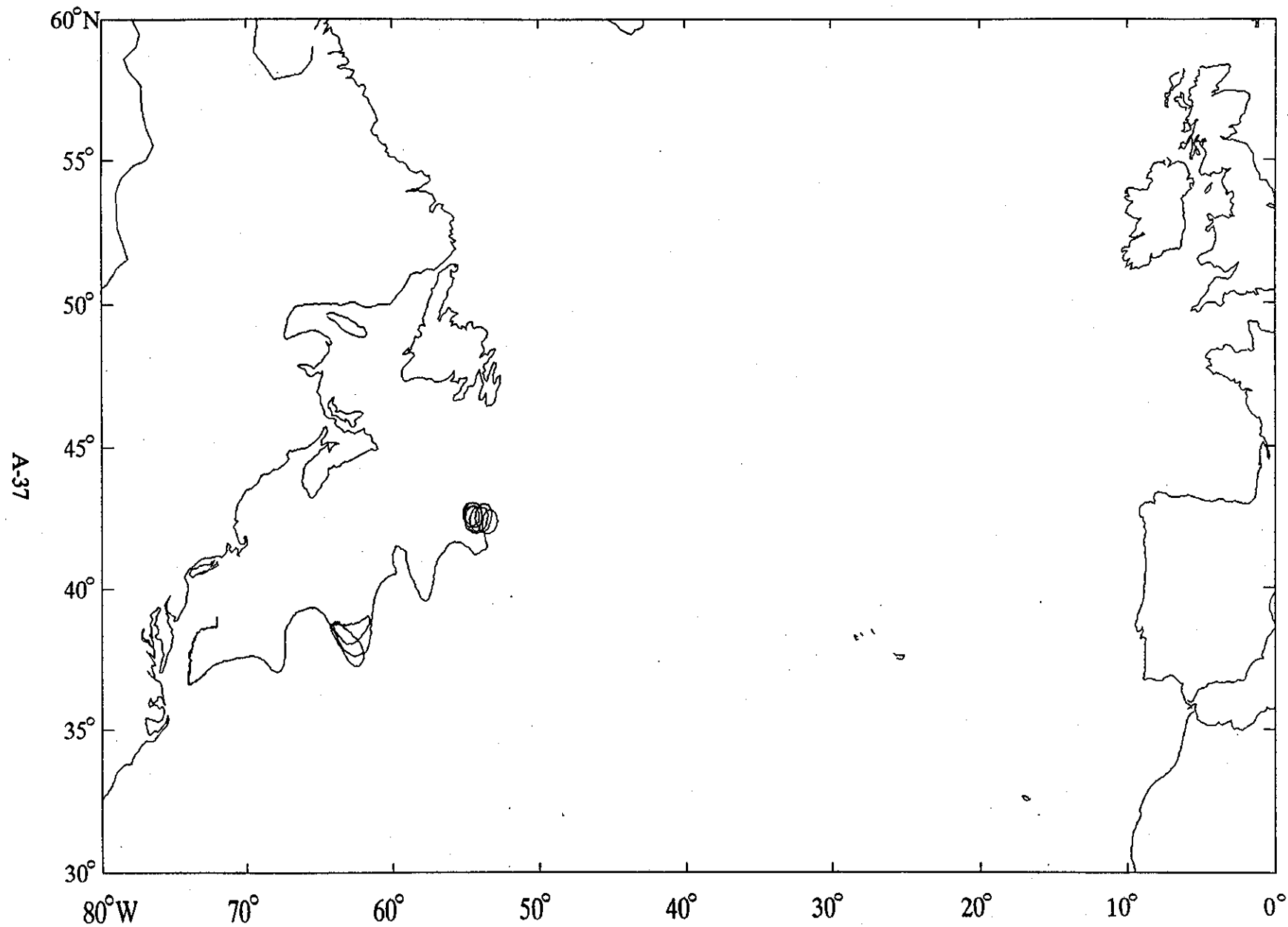
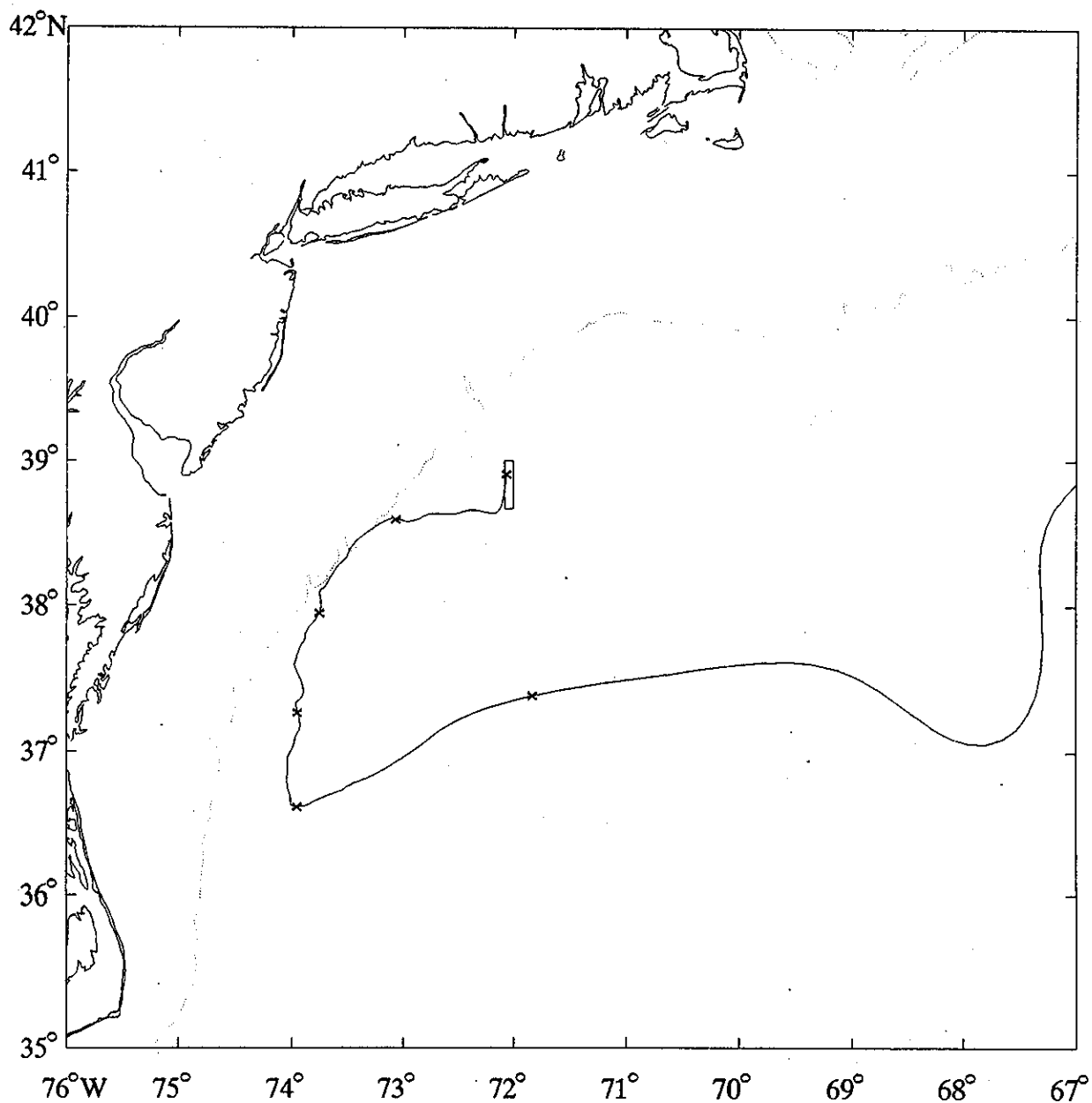


Figure A-13(a). Trajectory of Drifter Number 12732 Deployed on April 22, 1990.

The last transmission was on August 23, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-13(b). Trajectory of Drifter Number 12732 Deployed on April 22, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-39

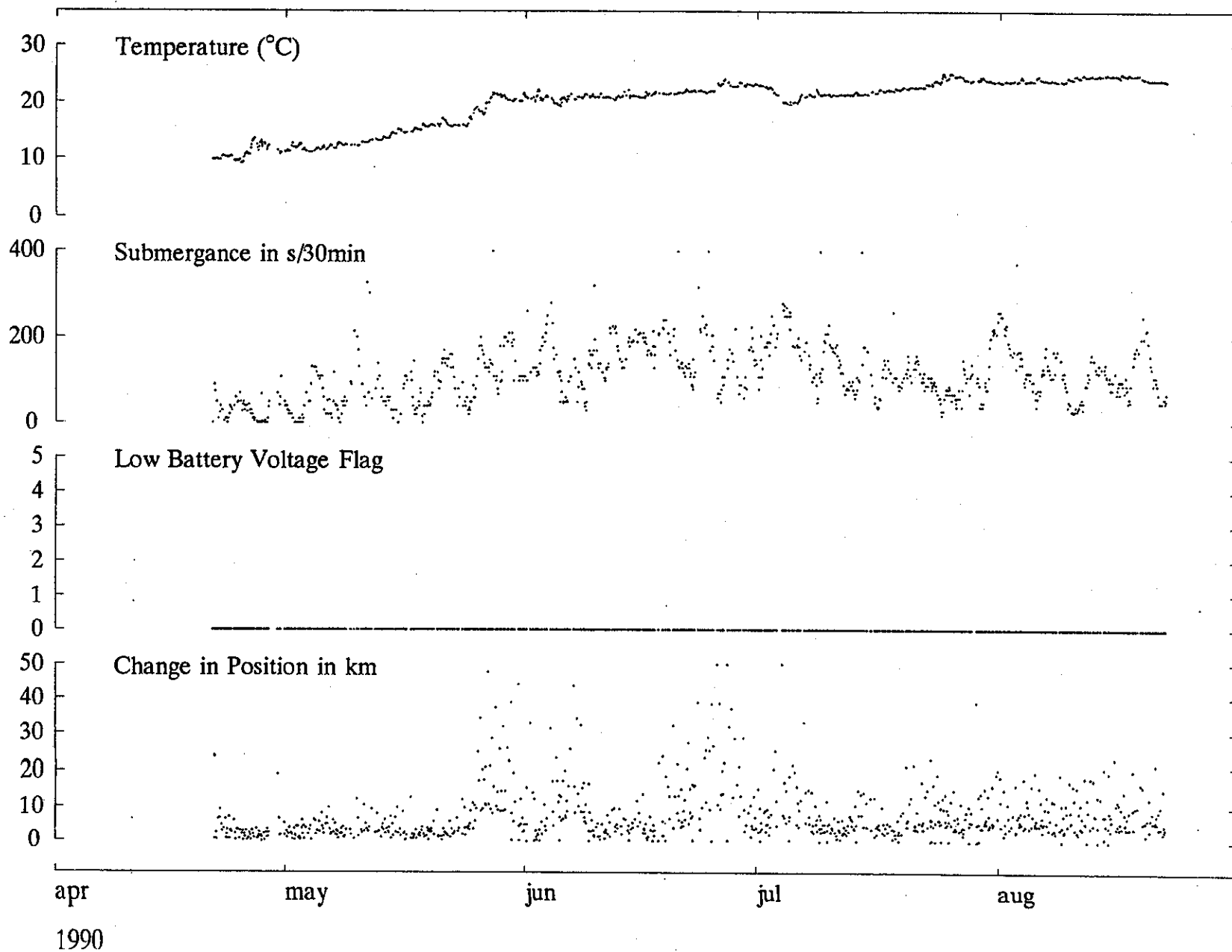


Figure A-13(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12732.

The data have been quality-assured, removing transmission errors and wild points.

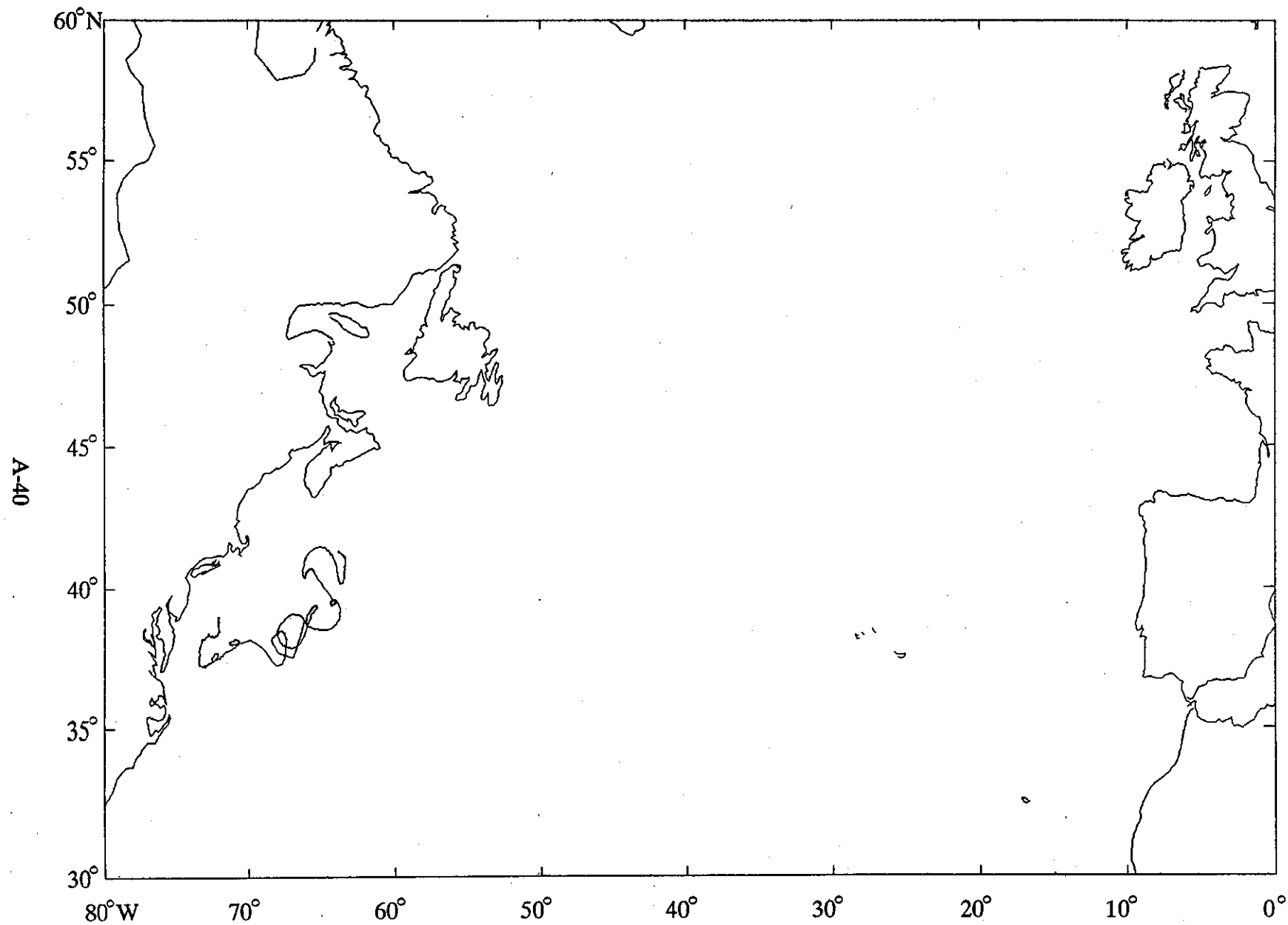
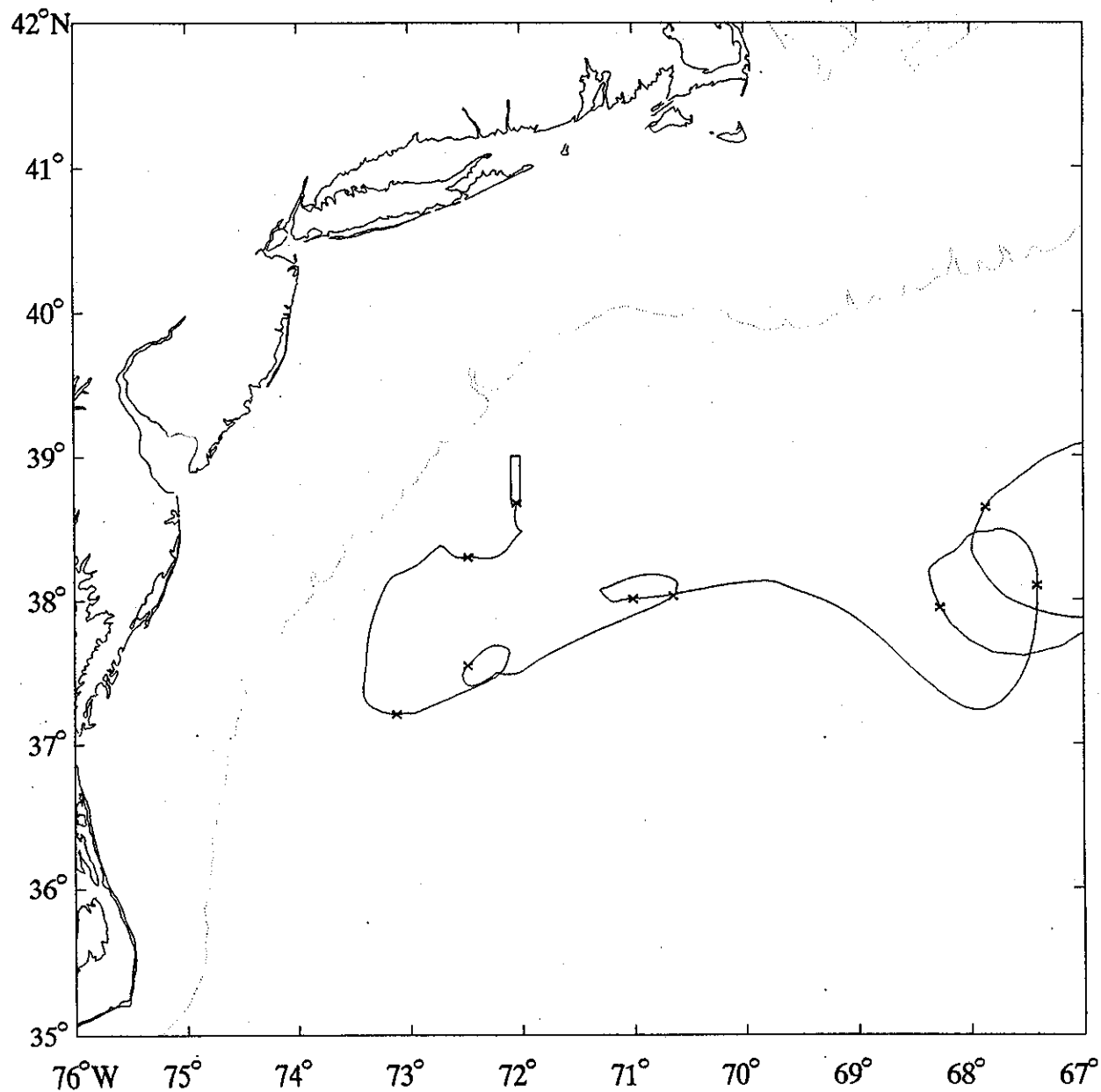


Figure A-14(a). Trajectory of Drifter Number 12733 Deployed on April 27, 1990.

The last transmission was on August 29, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-14(b). Trajectory of Drifter Number 12733 Deployed on April 27, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-42

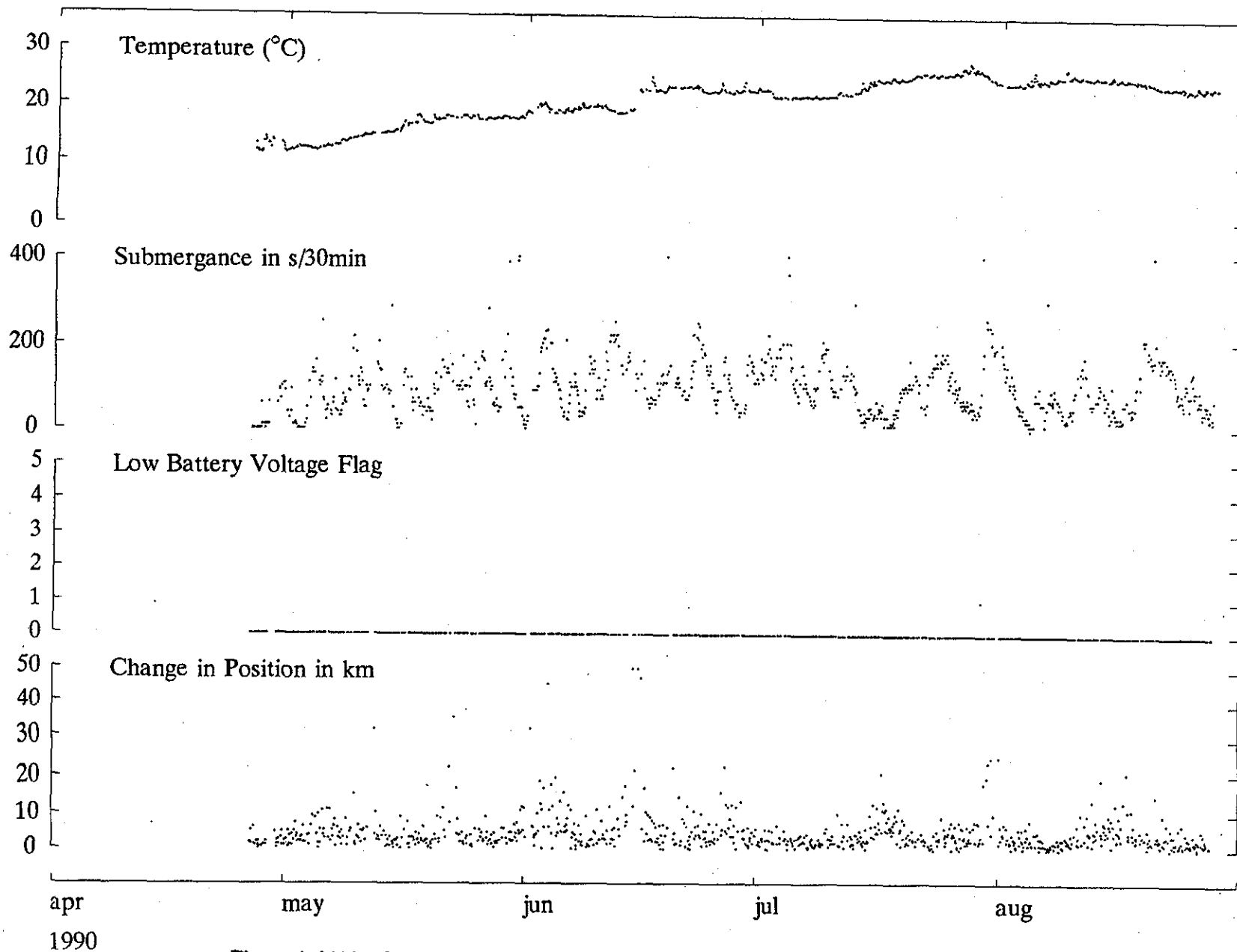


Figure A-14(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12733.

The data have been quality-assured, removing transmission errors and wild points.

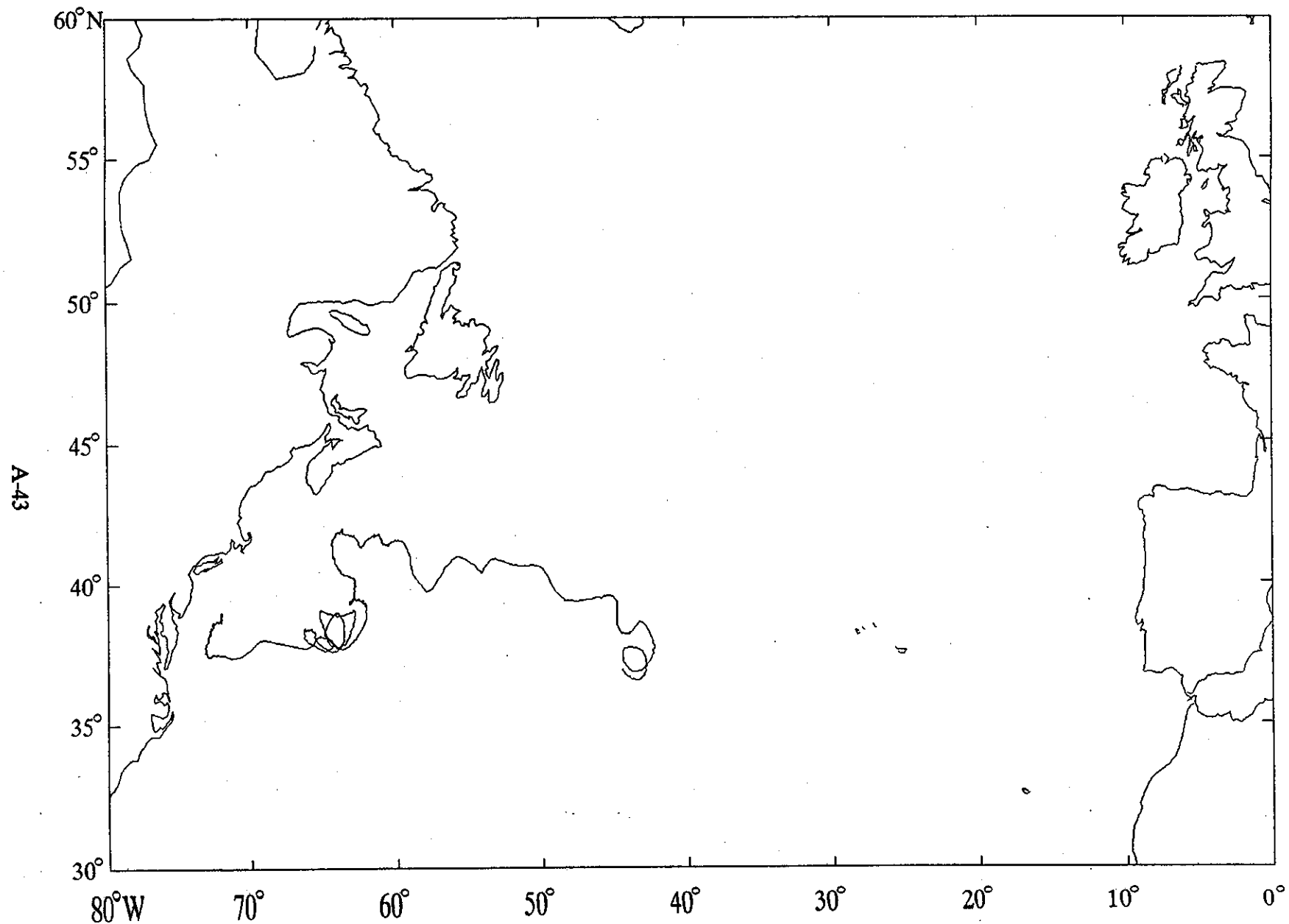
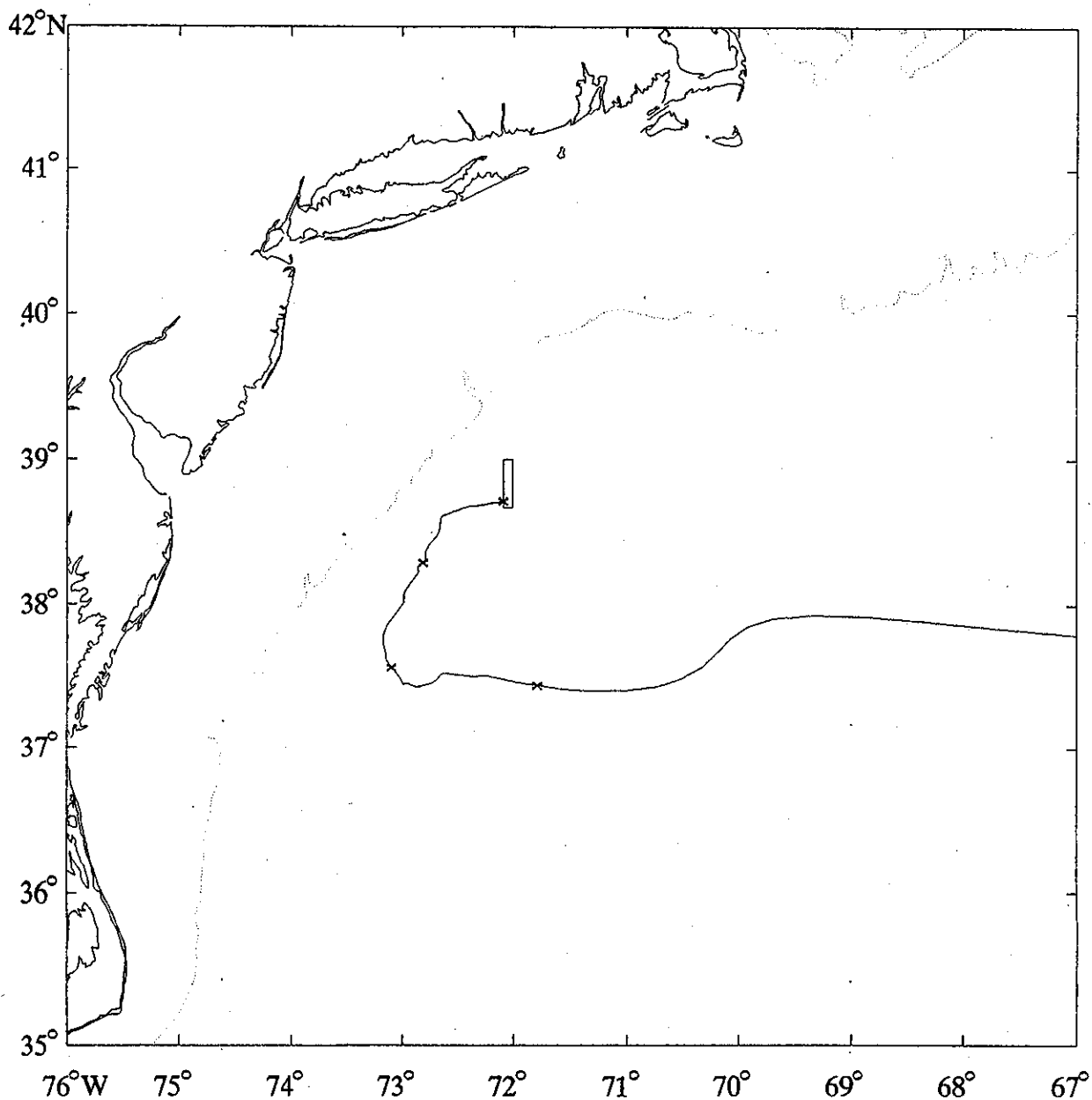


Figure A-15(a). Trajectory of Drifter Number 12734 Deployed on April 7, 1990.

The last transmission was on August 7, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-15(b). Trajectory of Drifter Number 12734 Deployed on April 7, 1990,
Shown in the Vicinity of the Mid- Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-45

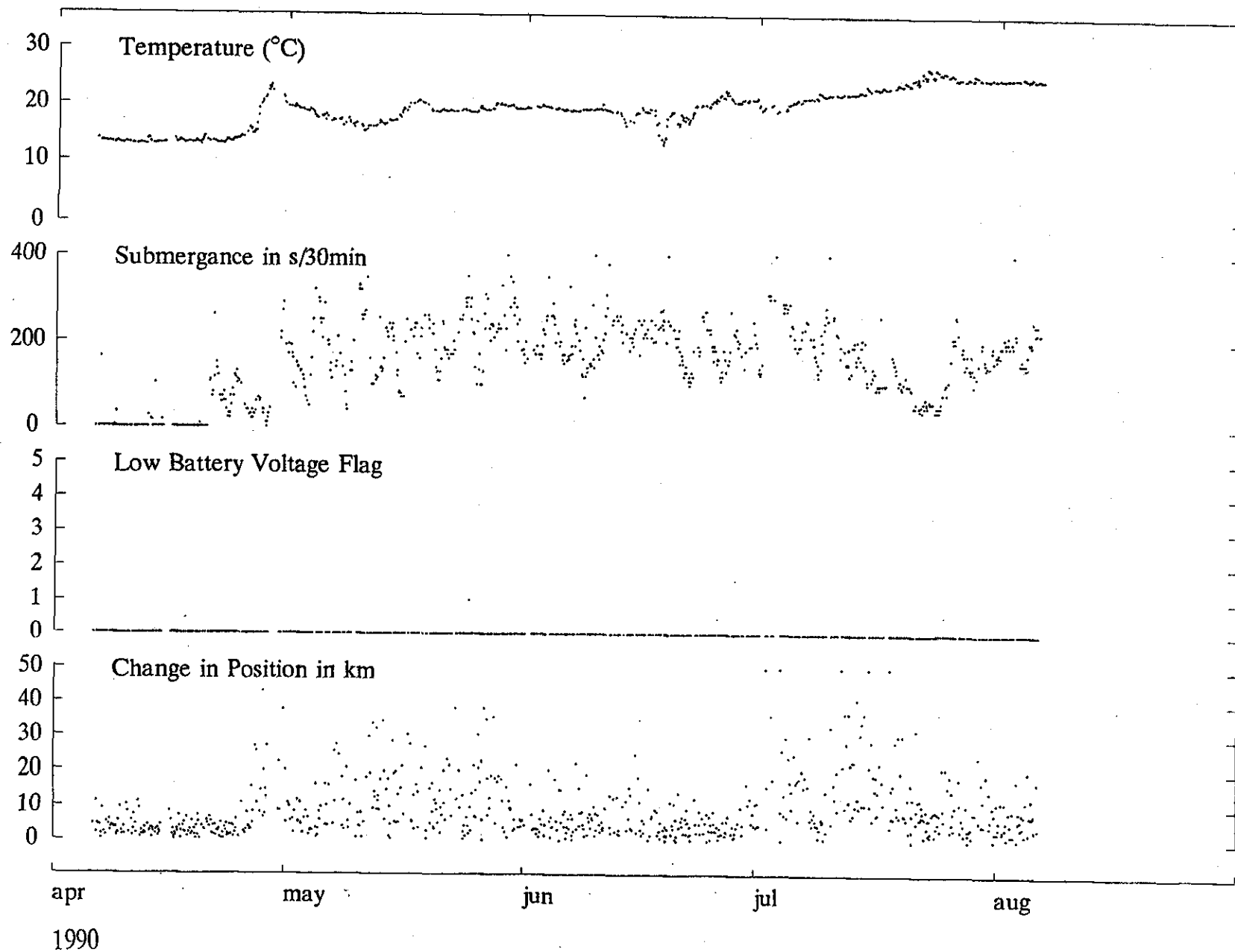


Figure A-15(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12734.

The data have been quality-assured, removing transmission errors and wild points.

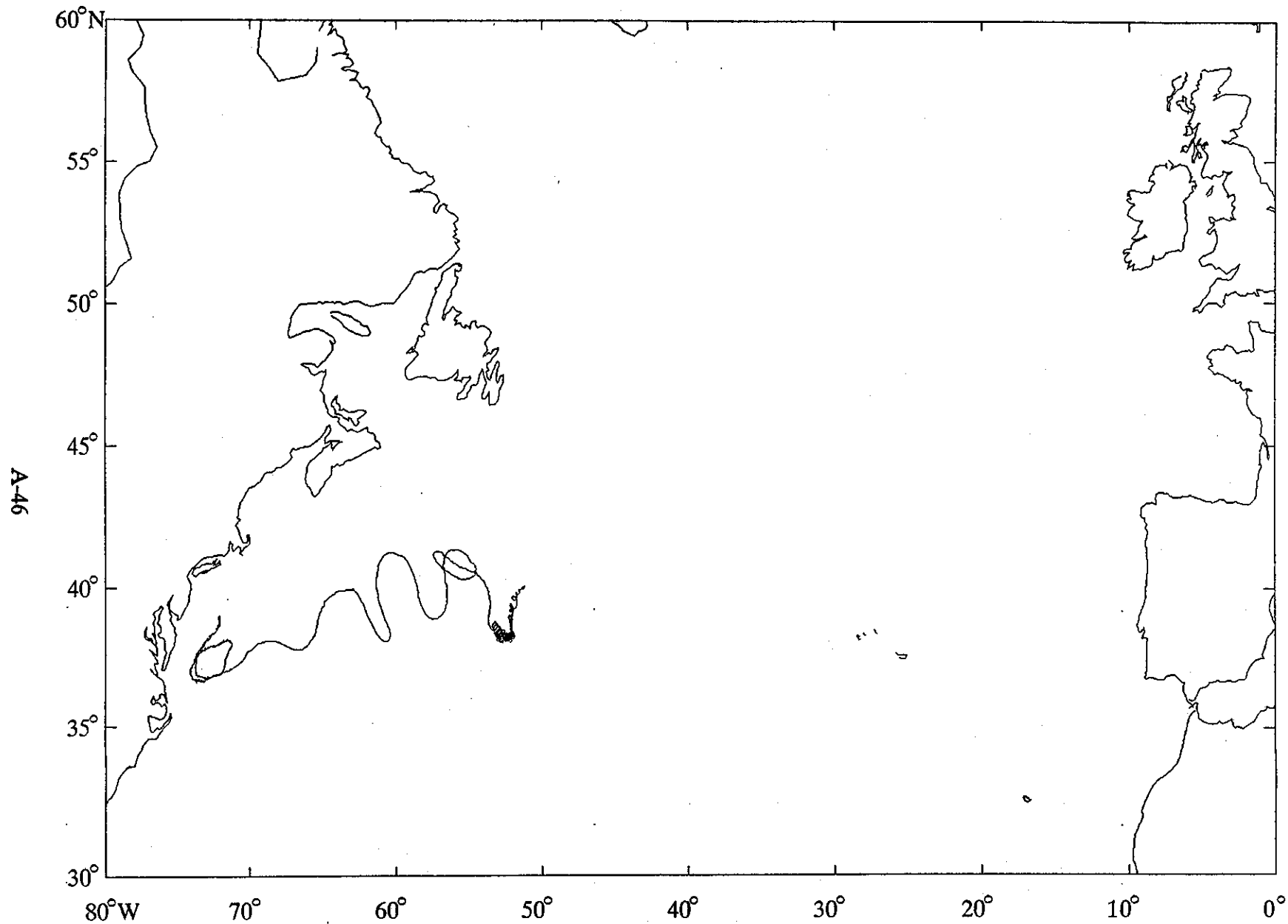
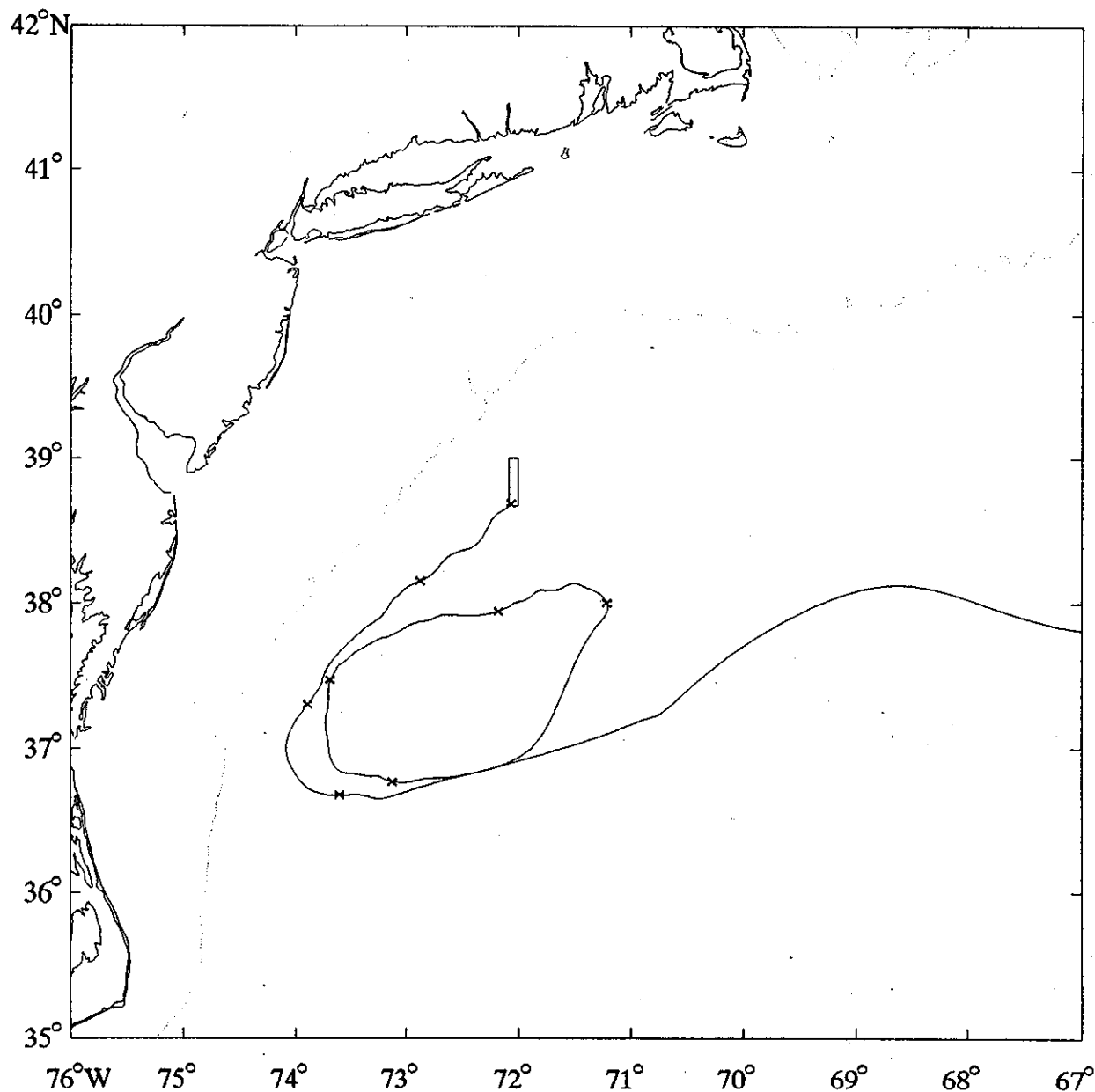


Figure A-16(a). Trajectory of Drifter Number 12735 Deployed on May 8, 1990.

The last transmission was on September 9, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-16(b). Trajectory of Drifter Number 12735 Deployed on May 8, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-48

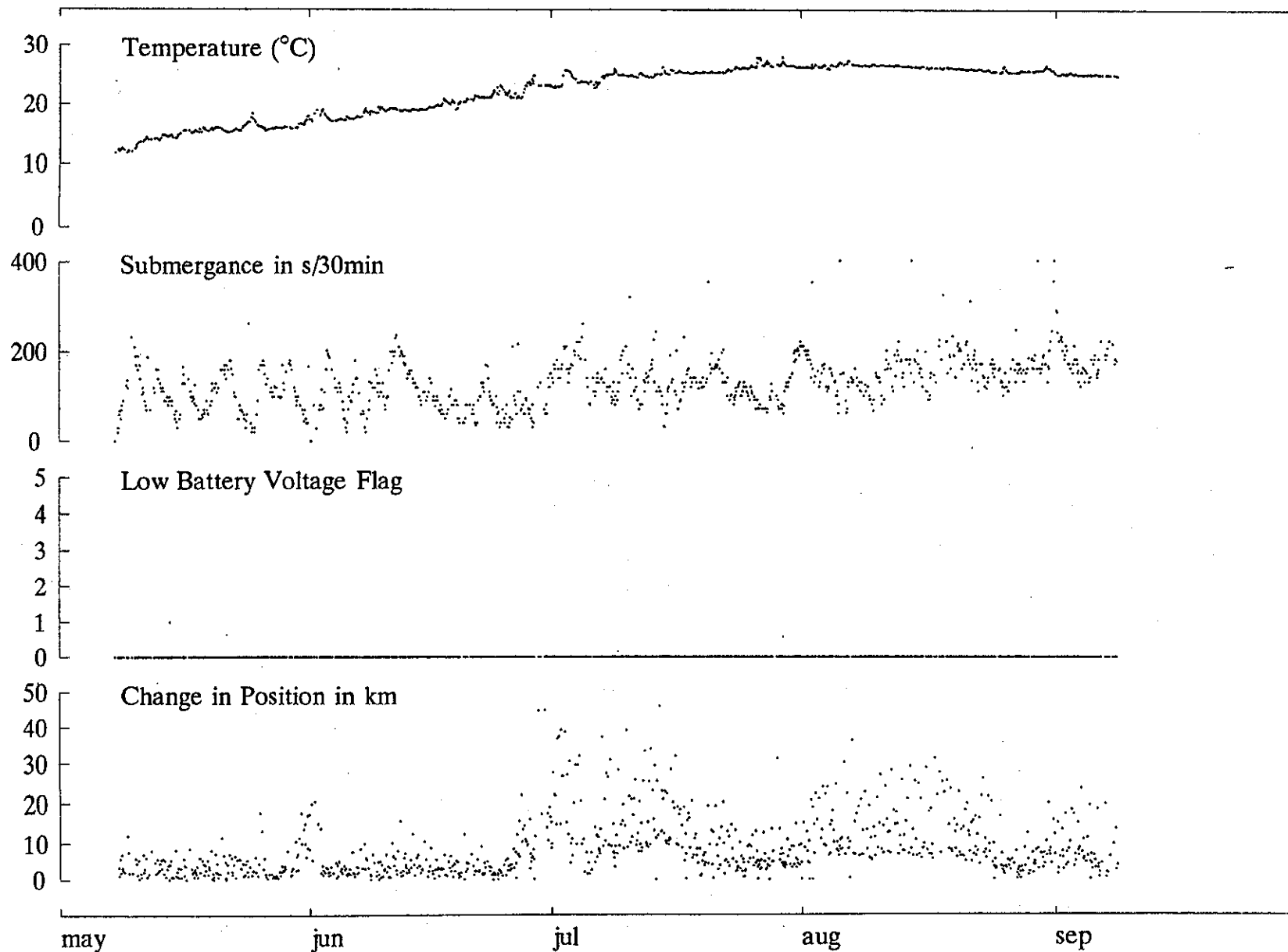


Figure A-16(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12735.

The data have been quality-assured, removing transmission errors and wild points.

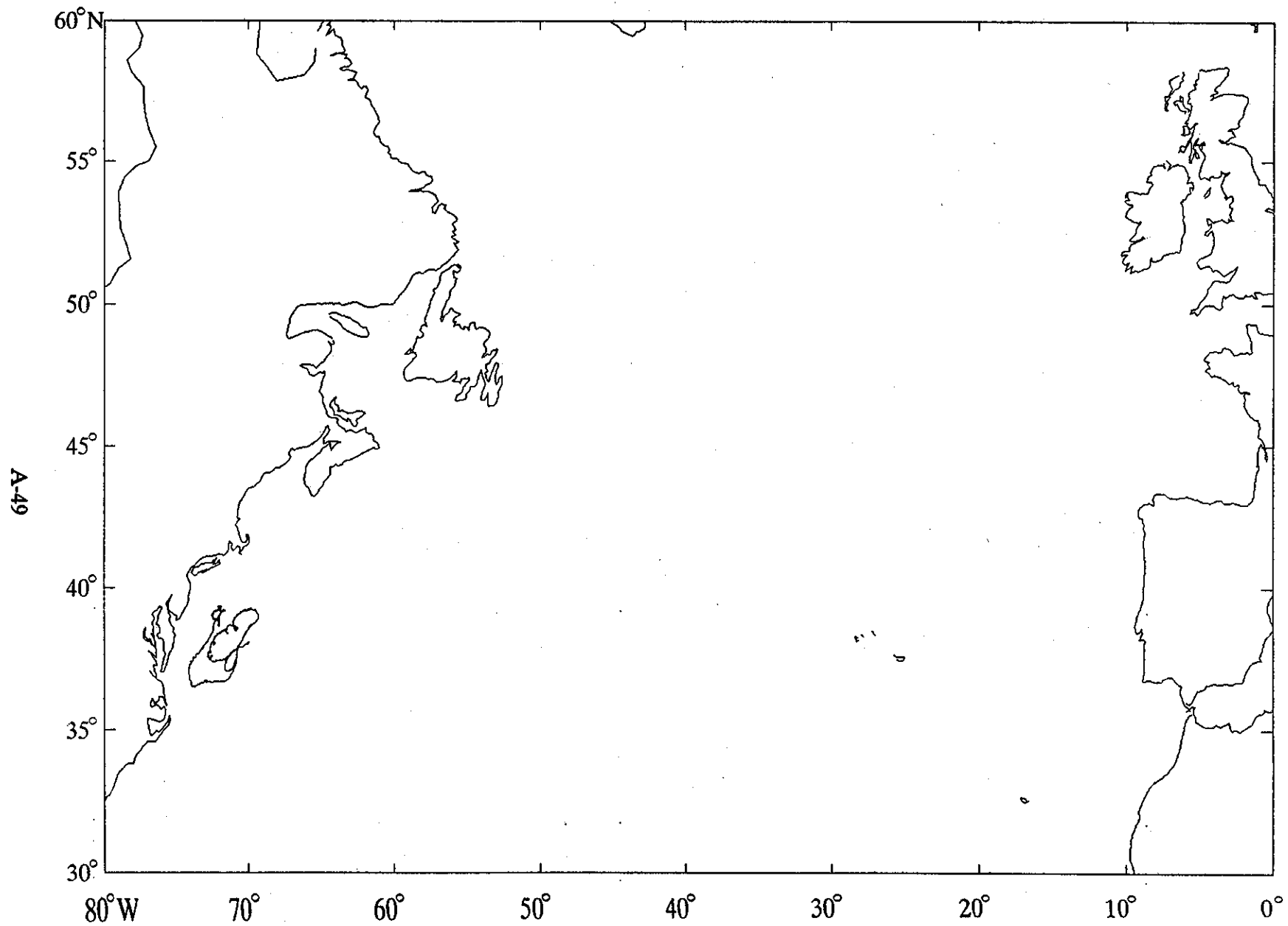
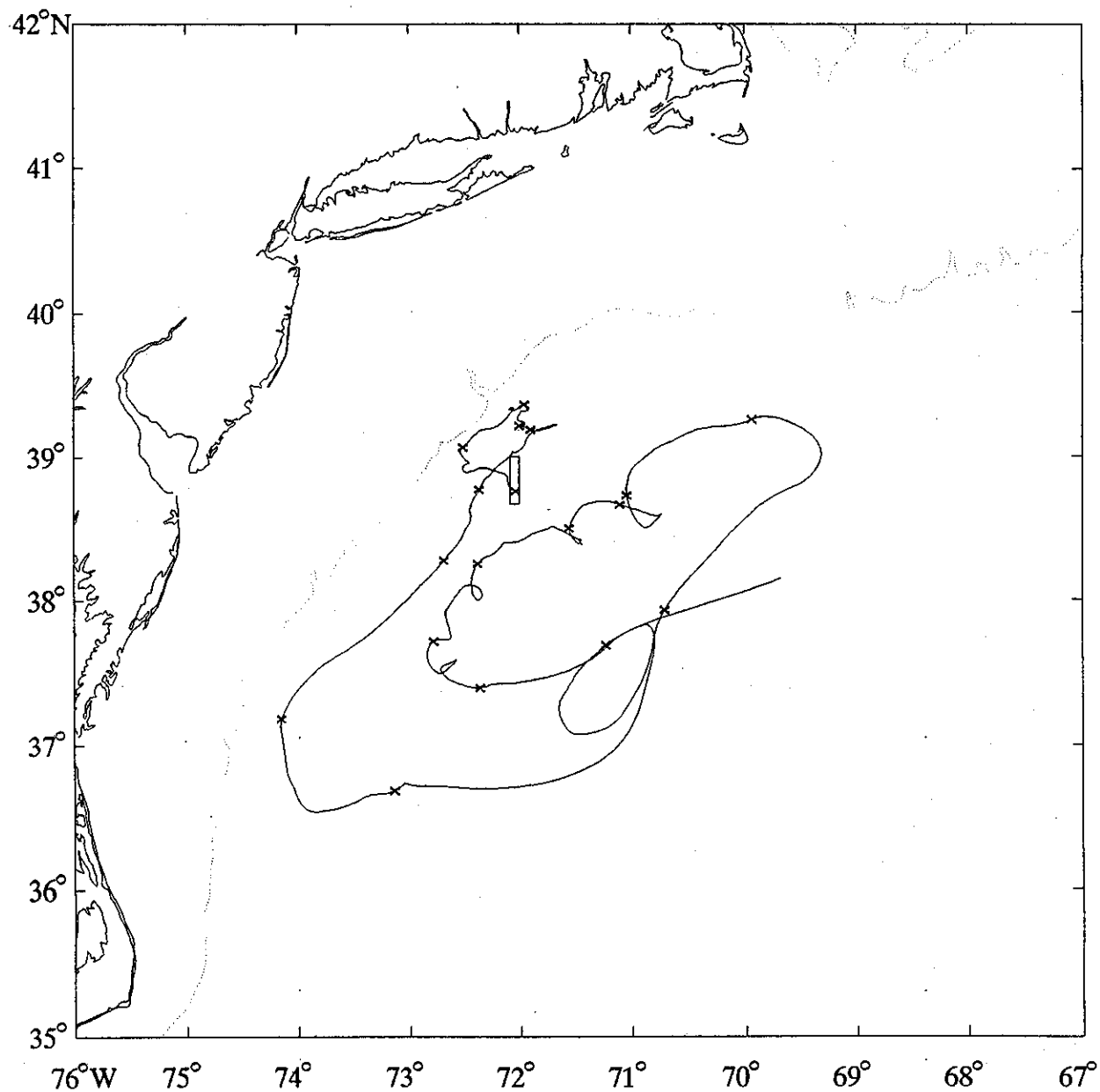


Figure A-17(a). Trajectory of Drifter Number 12736 Deployed on May 16, 1990.

The last transmission was on September 16, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-17(b). Trajectory of Drifter Number 12736 Deployed on May 16, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-51

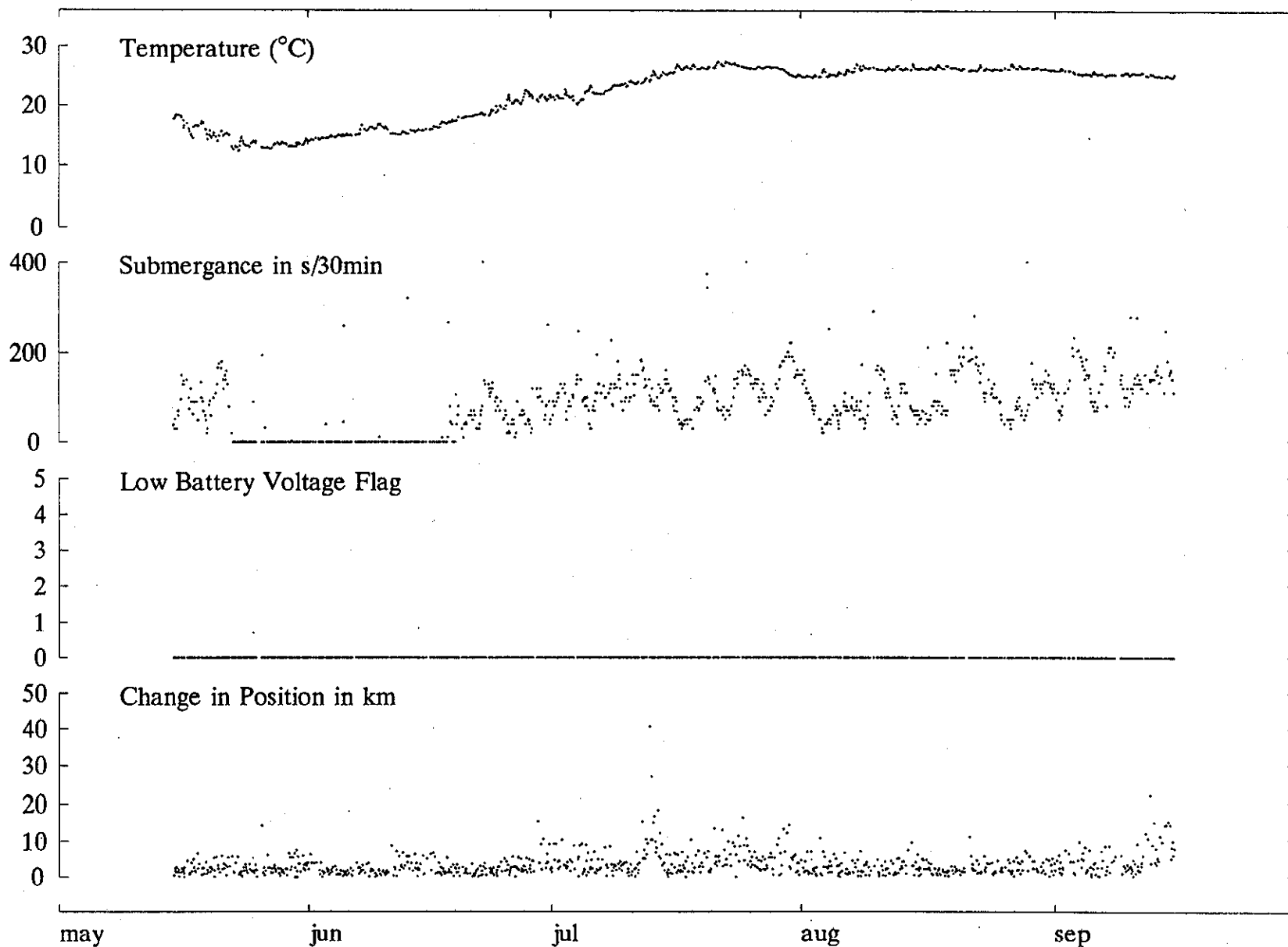


Figure A-17(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12736.

The data have been quality-assured, removing transmission errors and wild points.

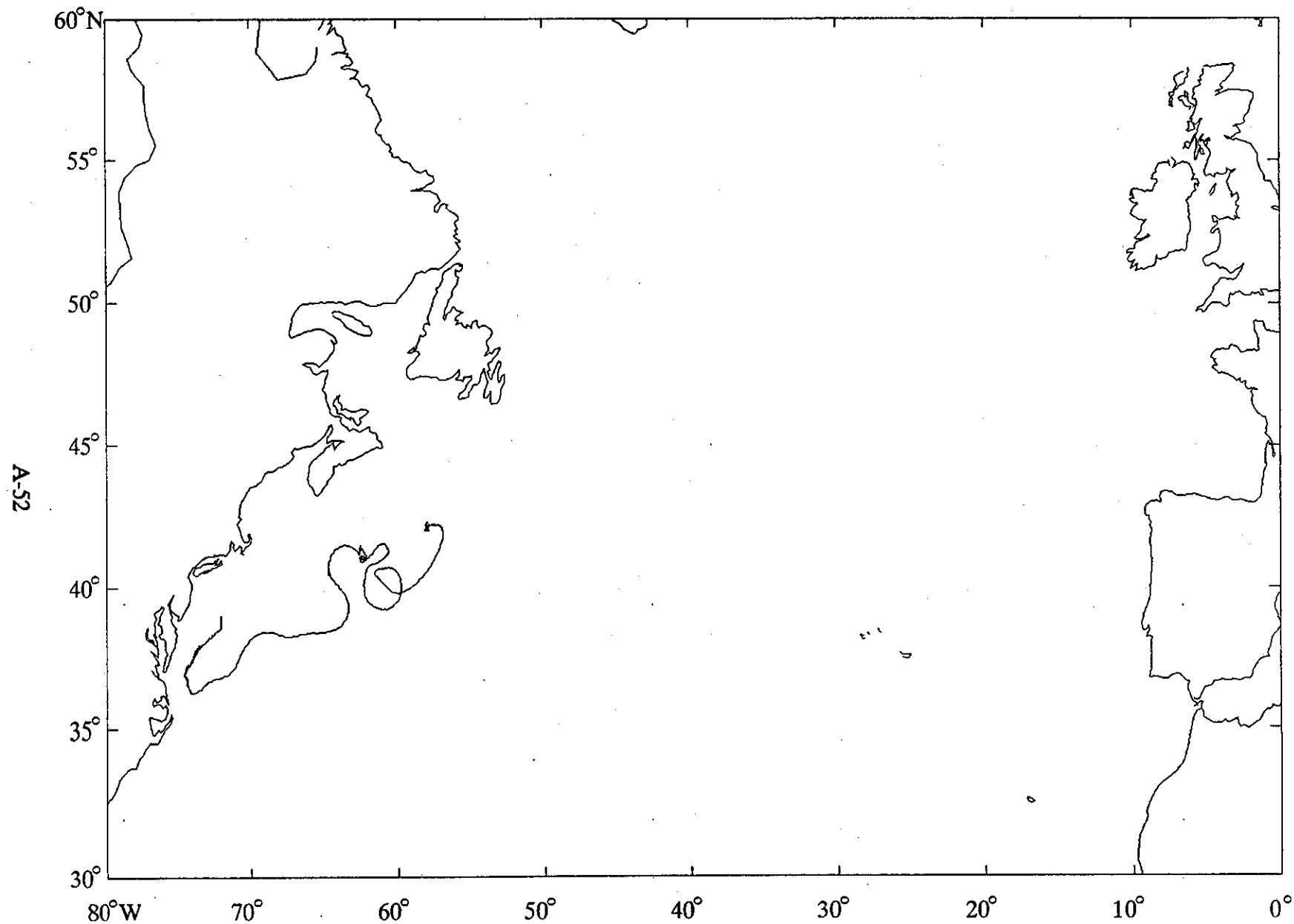
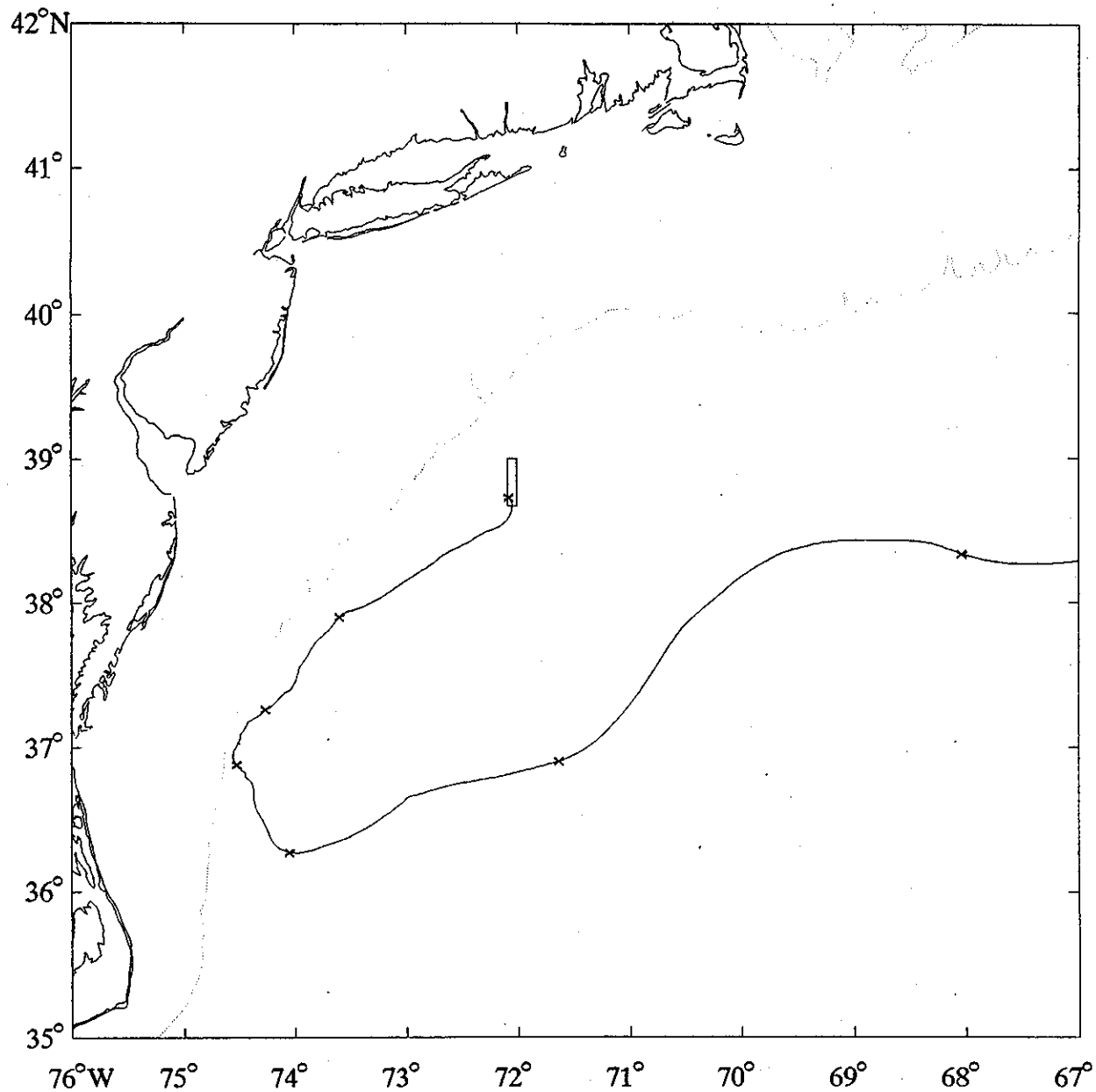


Figure A-17(a). Trajectory of Drifter Number 12737 Deployed on June 6, 1990.

The last transmission was on October 2, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-17(b). Trajectory of Drifter Number 12737 Deployed on June 6, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-54

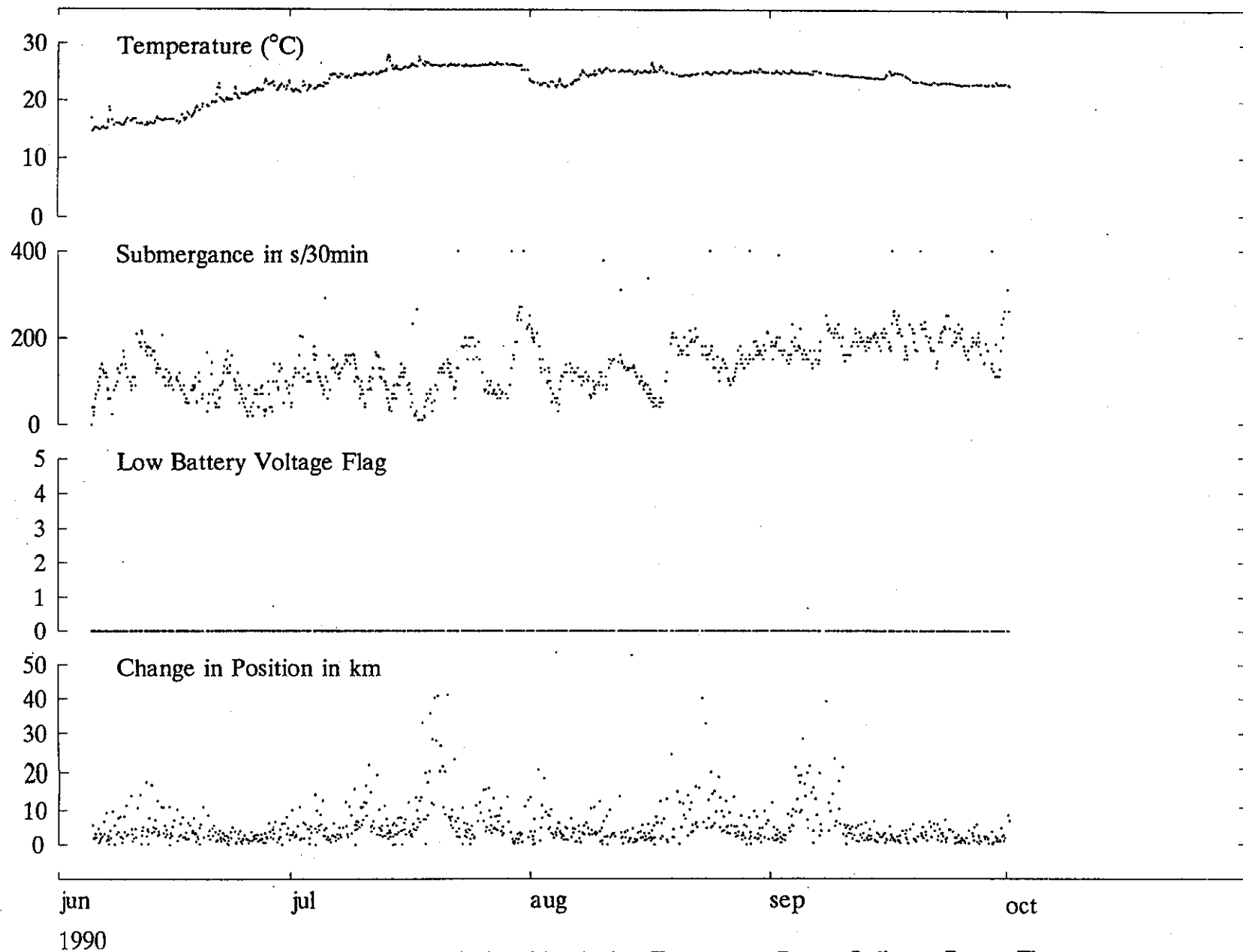


Figure A-17(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12737.

The data have been quality-assured, removing transmission errors and wild points.

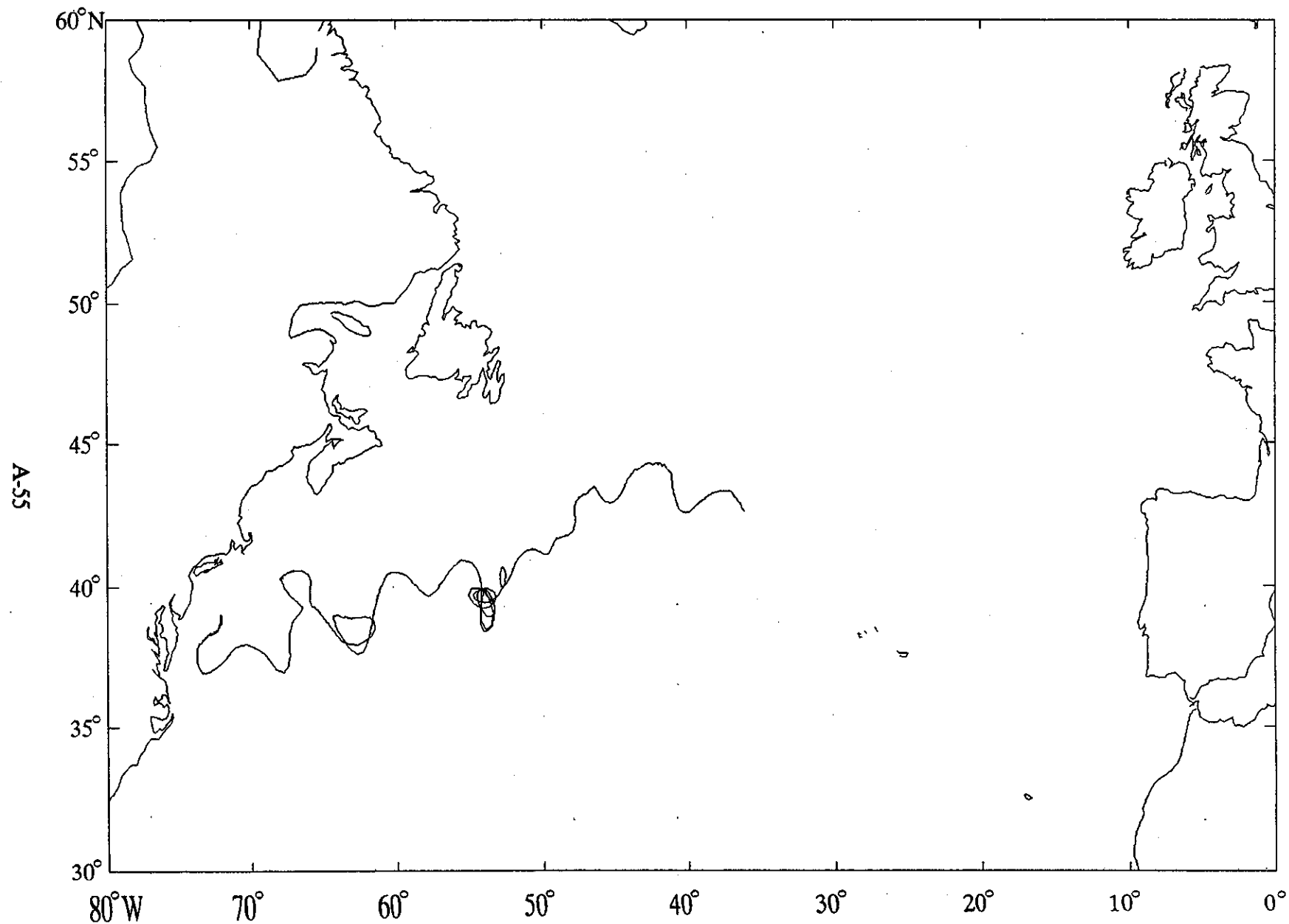
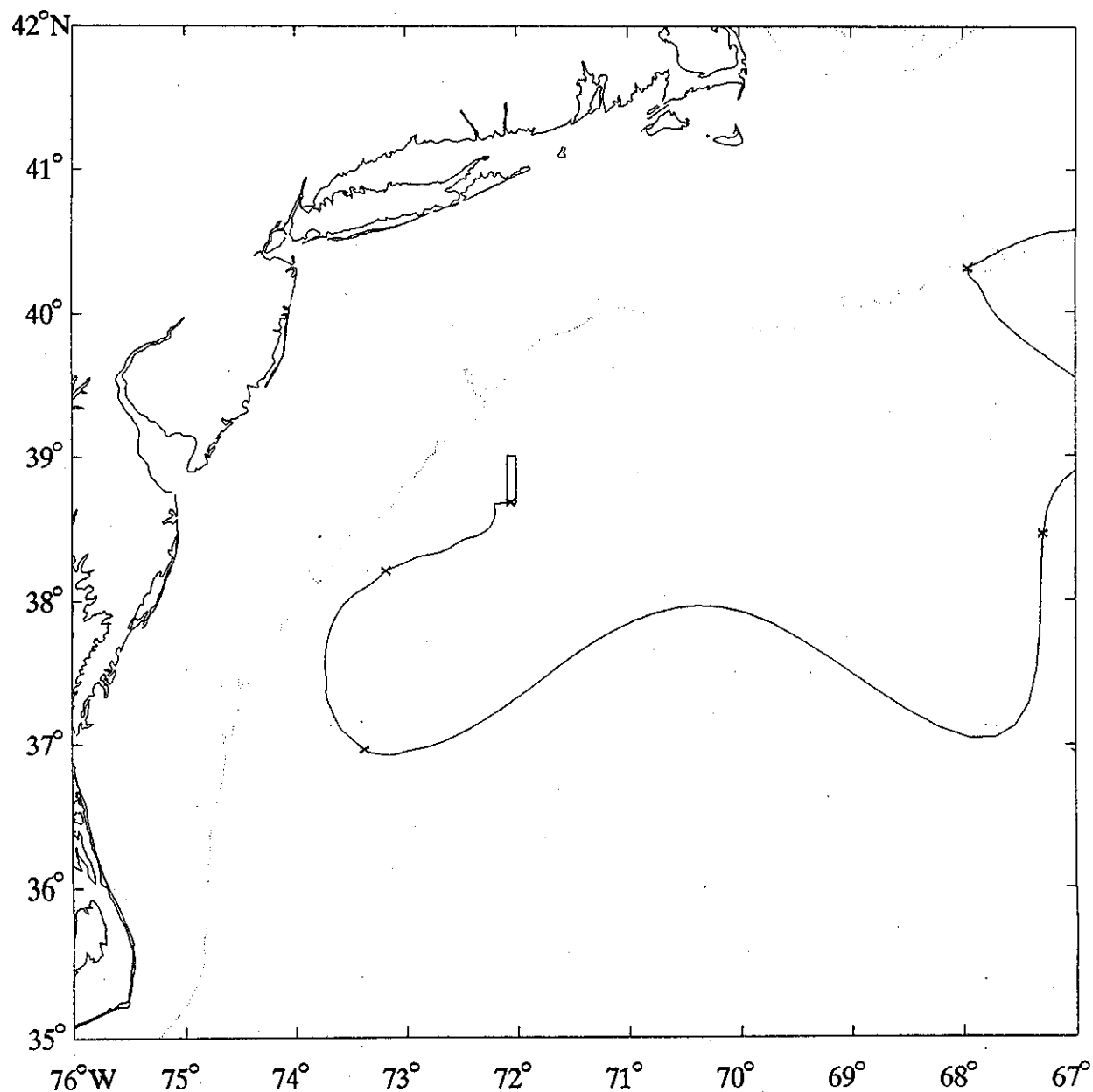


Figure A-18(a). Trajectory of Drifter Number 12738 Deployed on May 4, 1990.

The last transmission was on September 4, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-18(b). Trajectory of Drifter Number 12738 Deployed on May 4, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-57

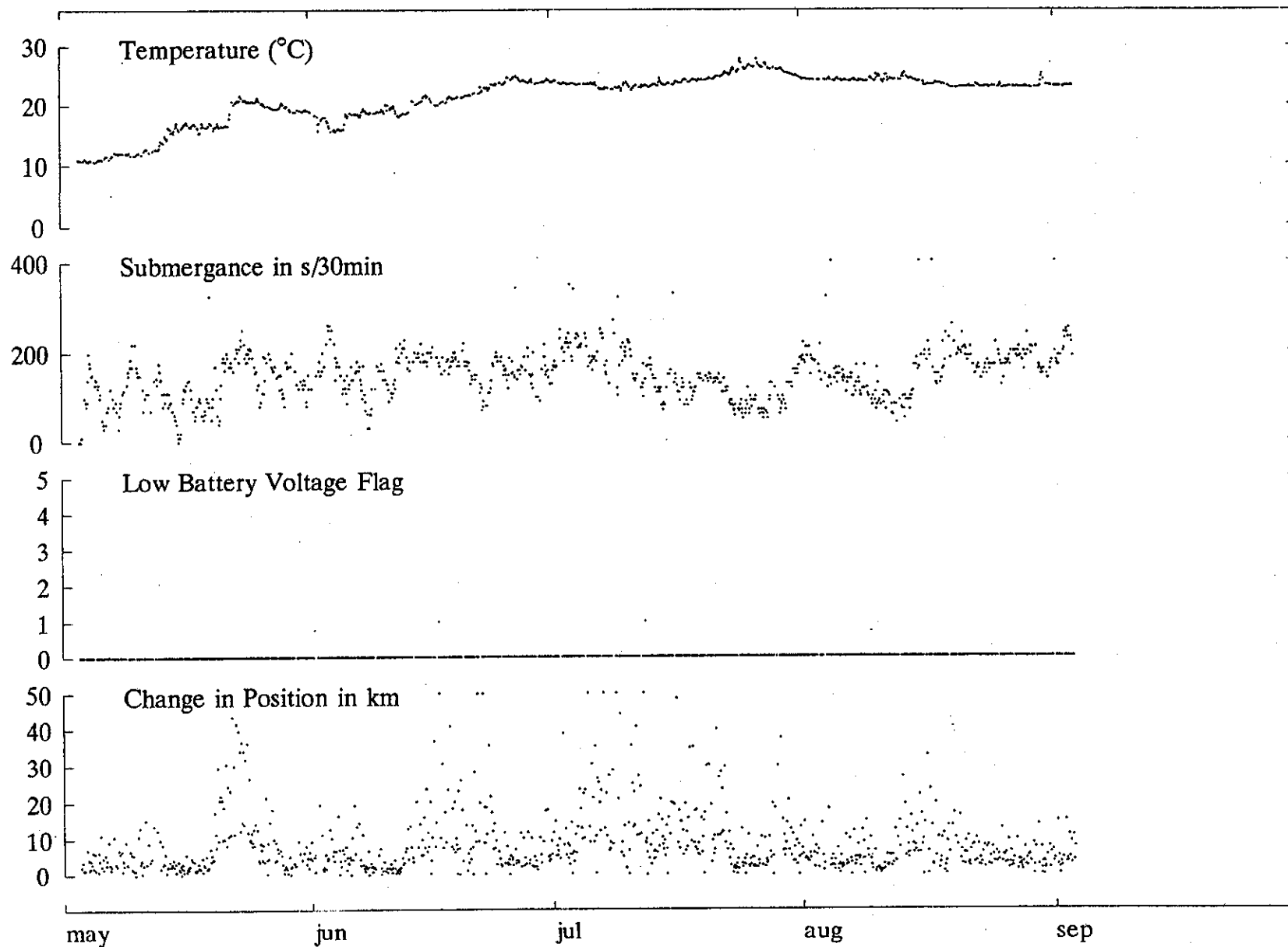


Figure A-18(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12738.

The data have been quality-assured, removing transmission errors and wild points.

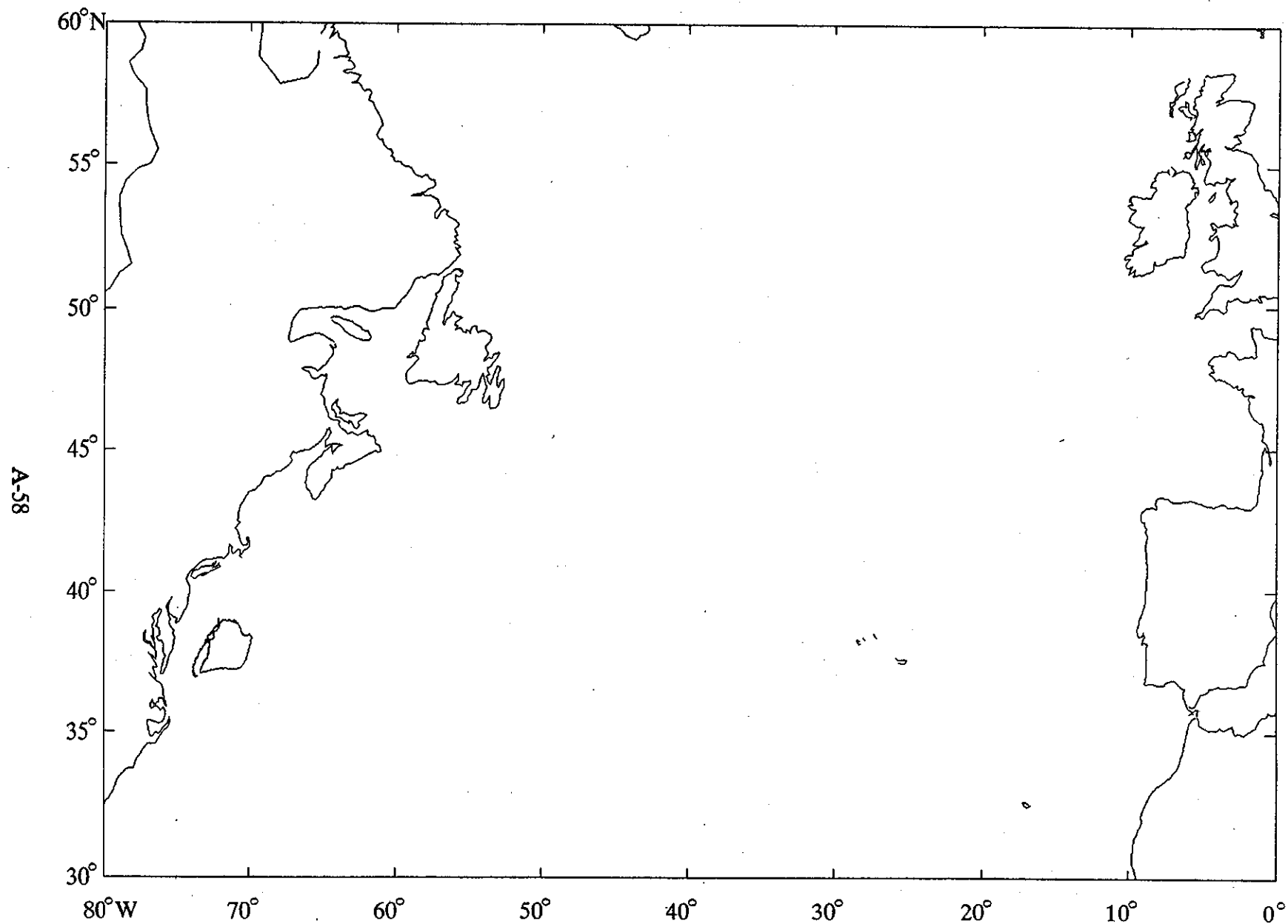
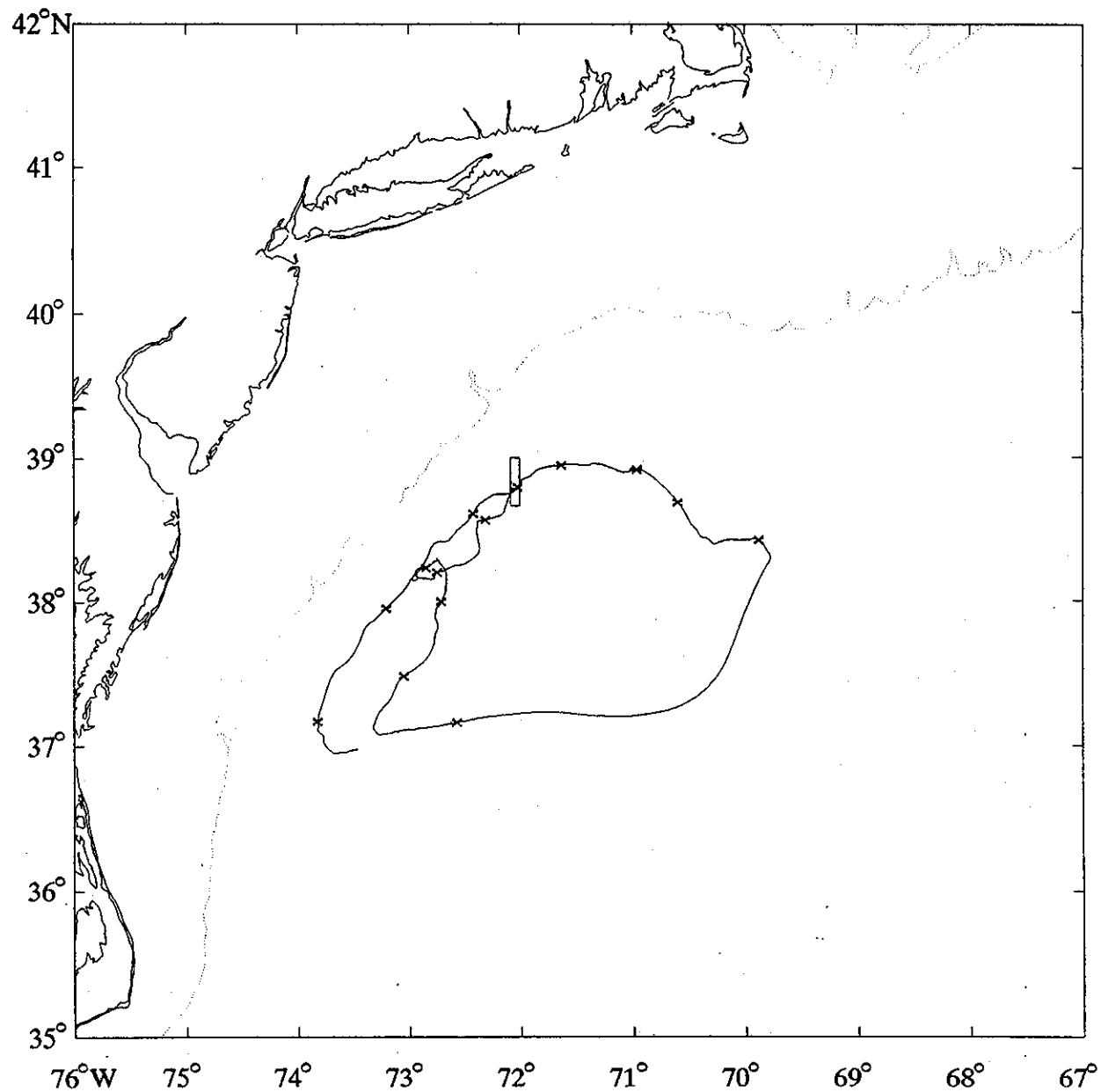


Figure A-19(a). Trajectory of Drifter Number 12739 Deployed on June 26, 1990.

The last transmission was on October 2, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-19(b). Trajectory of Drifter Number 12739 Deployed on June 26, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

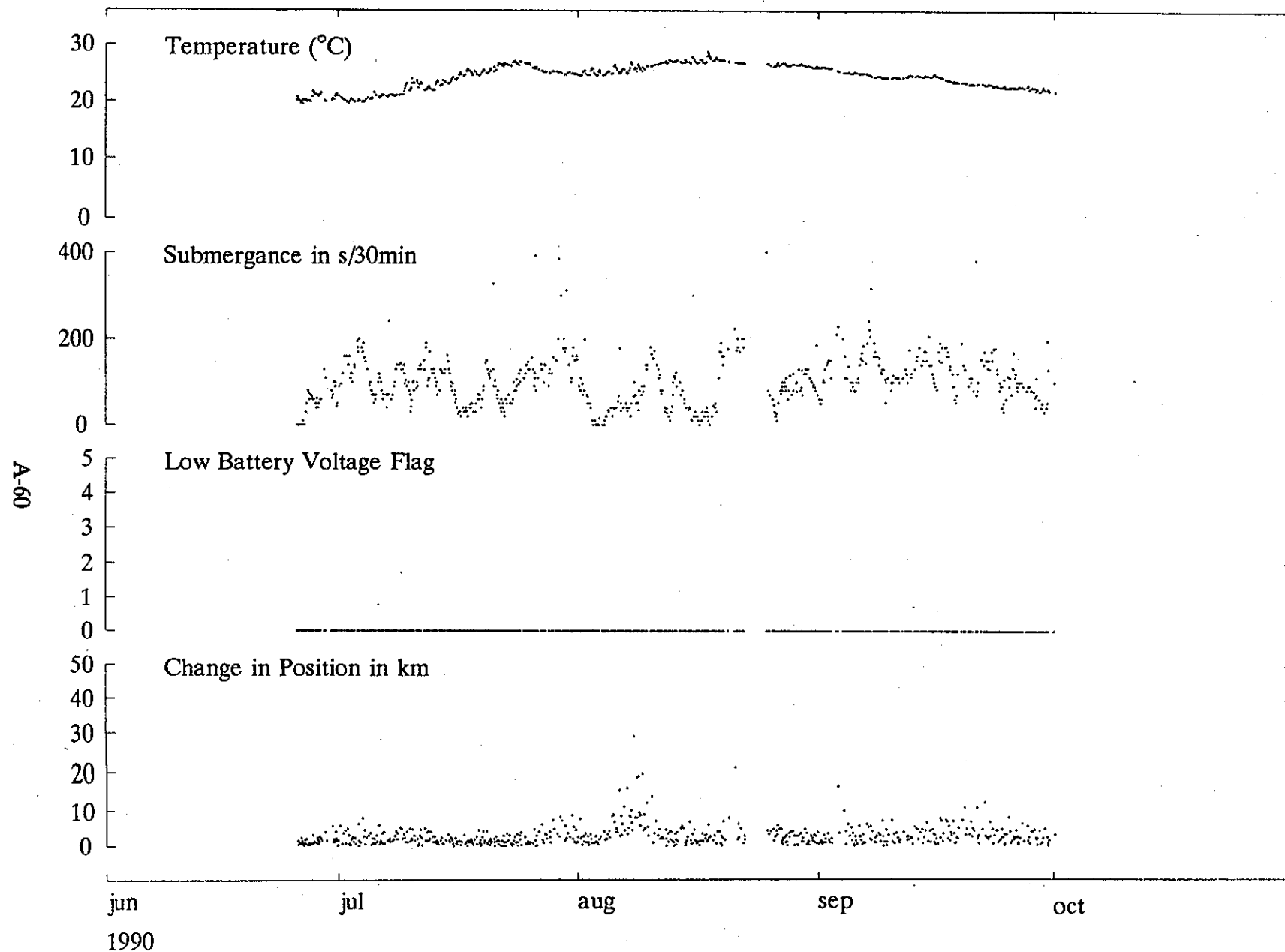


Figure A-19(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12739.

The data have been quality-assured, removing transmission errors and wild points.

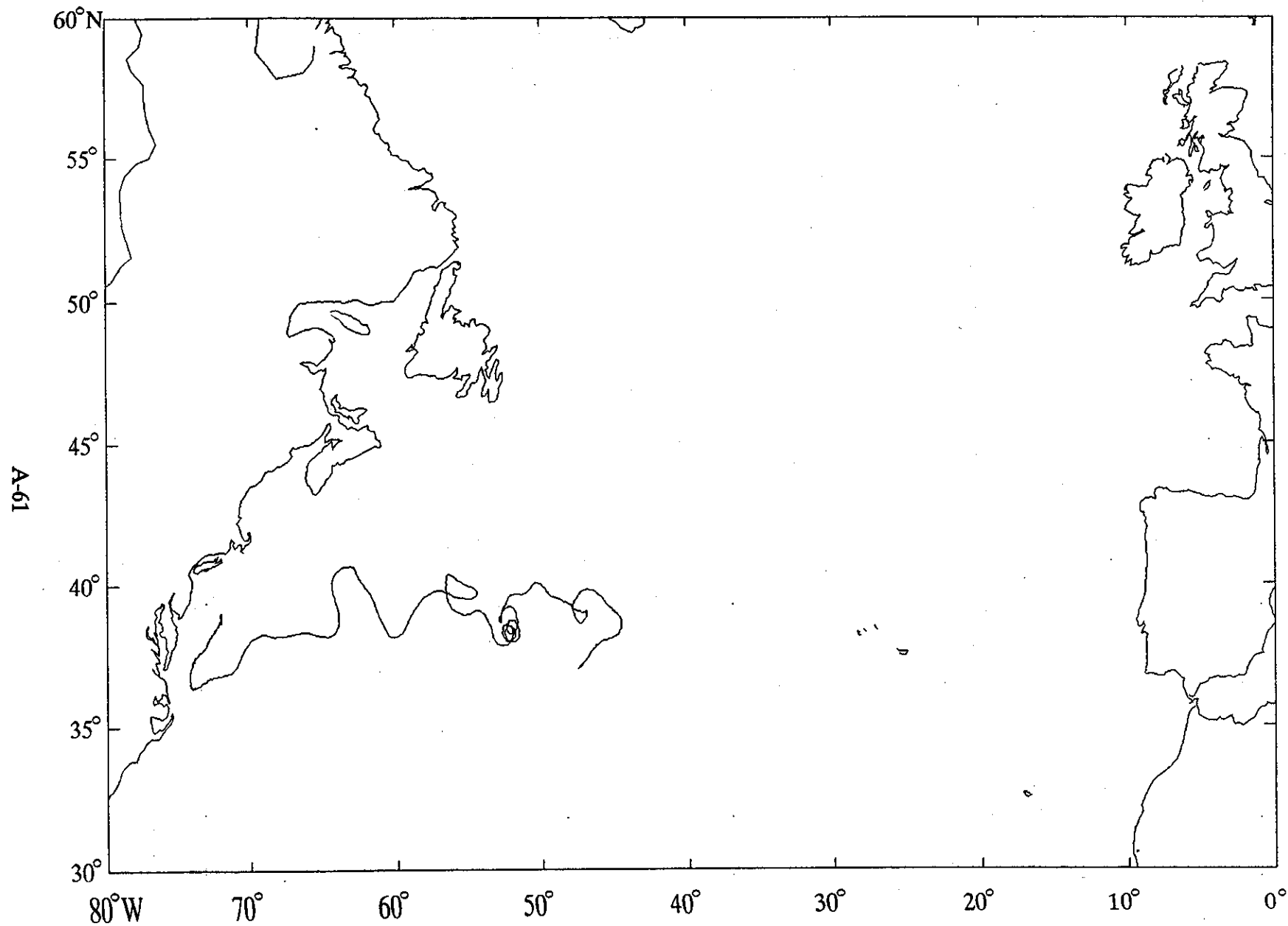


Figure A-20(a). Trajectory of Drifter Number 12740 Deployed on June 13, 1990.

The last transmission was on October 14, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.

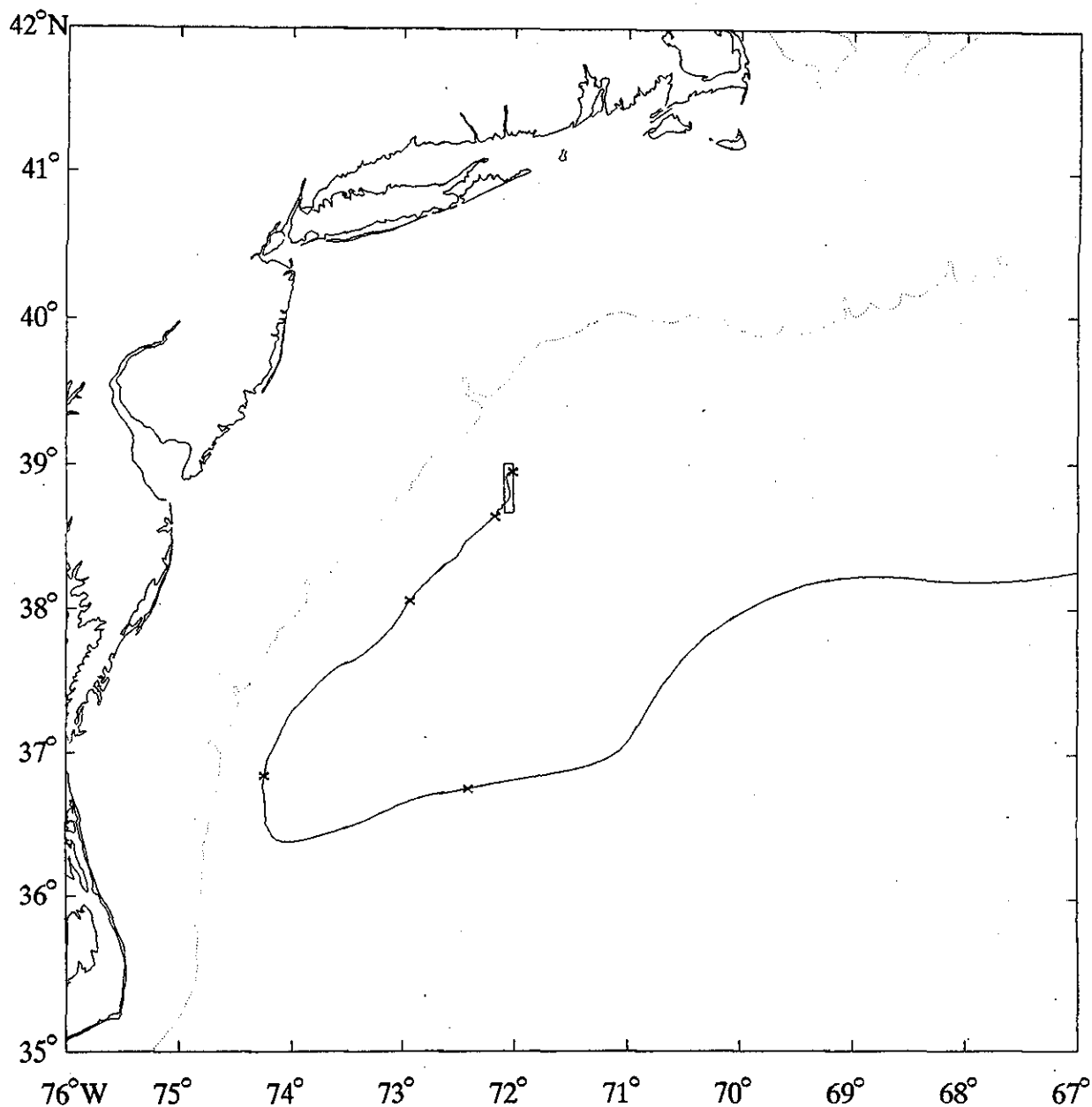


Figure A-20(b). Trajectory of Drifter Number 12740 Deployed on June 13, 1990, Shown in the Vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-63

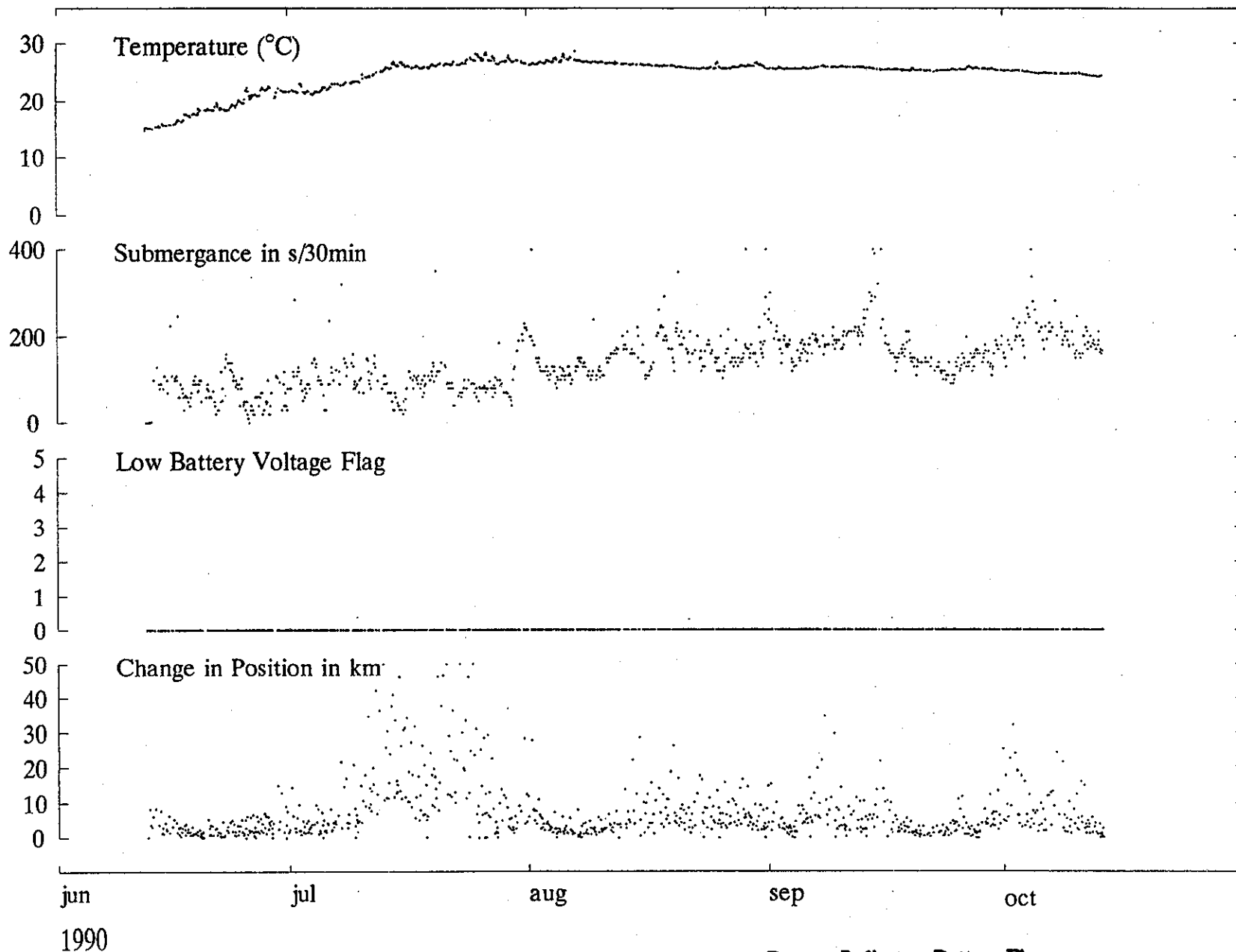


Figure A-20(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12740.

The data have been quality-assured, removing transmission errors and wild points.

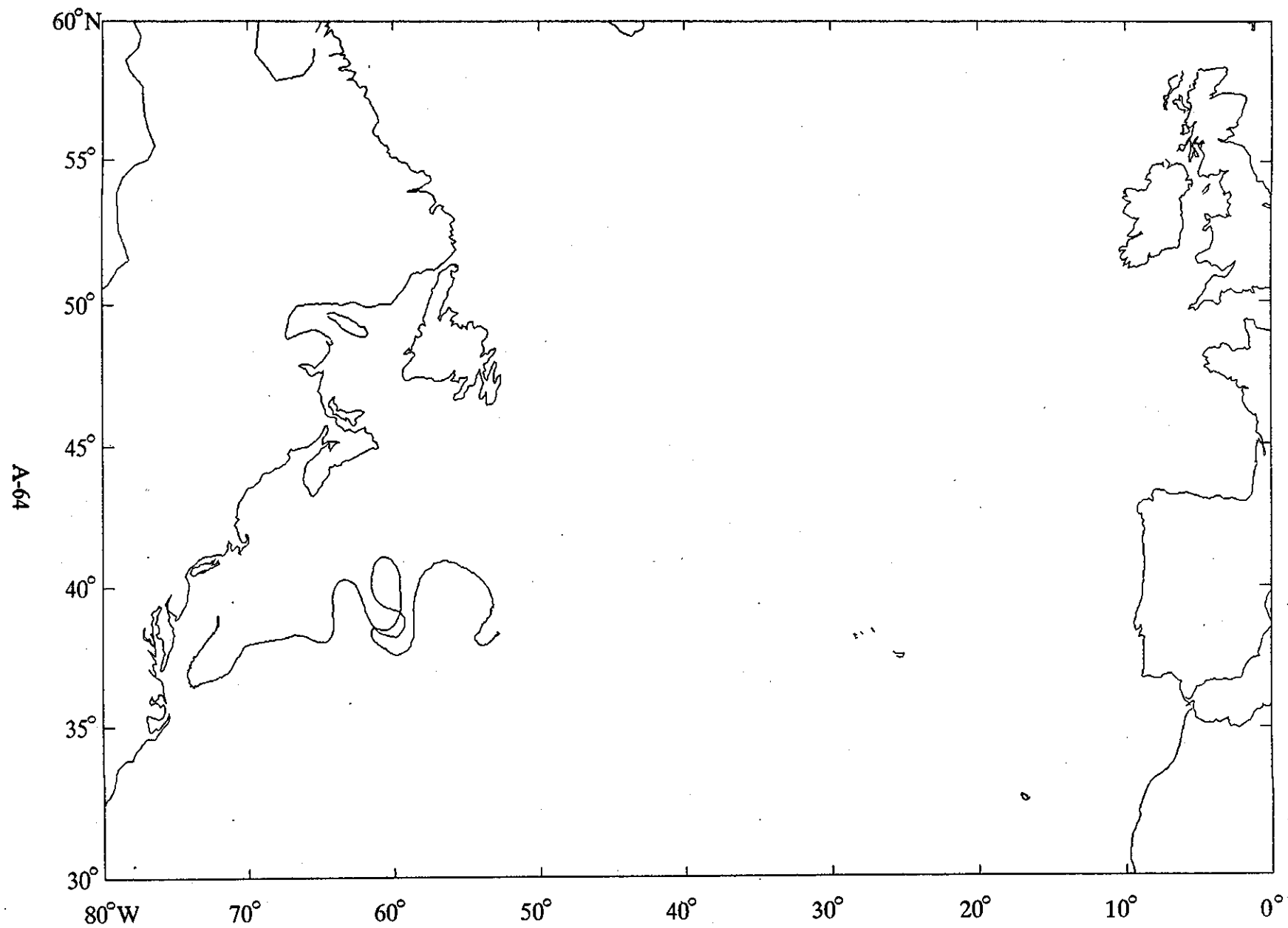
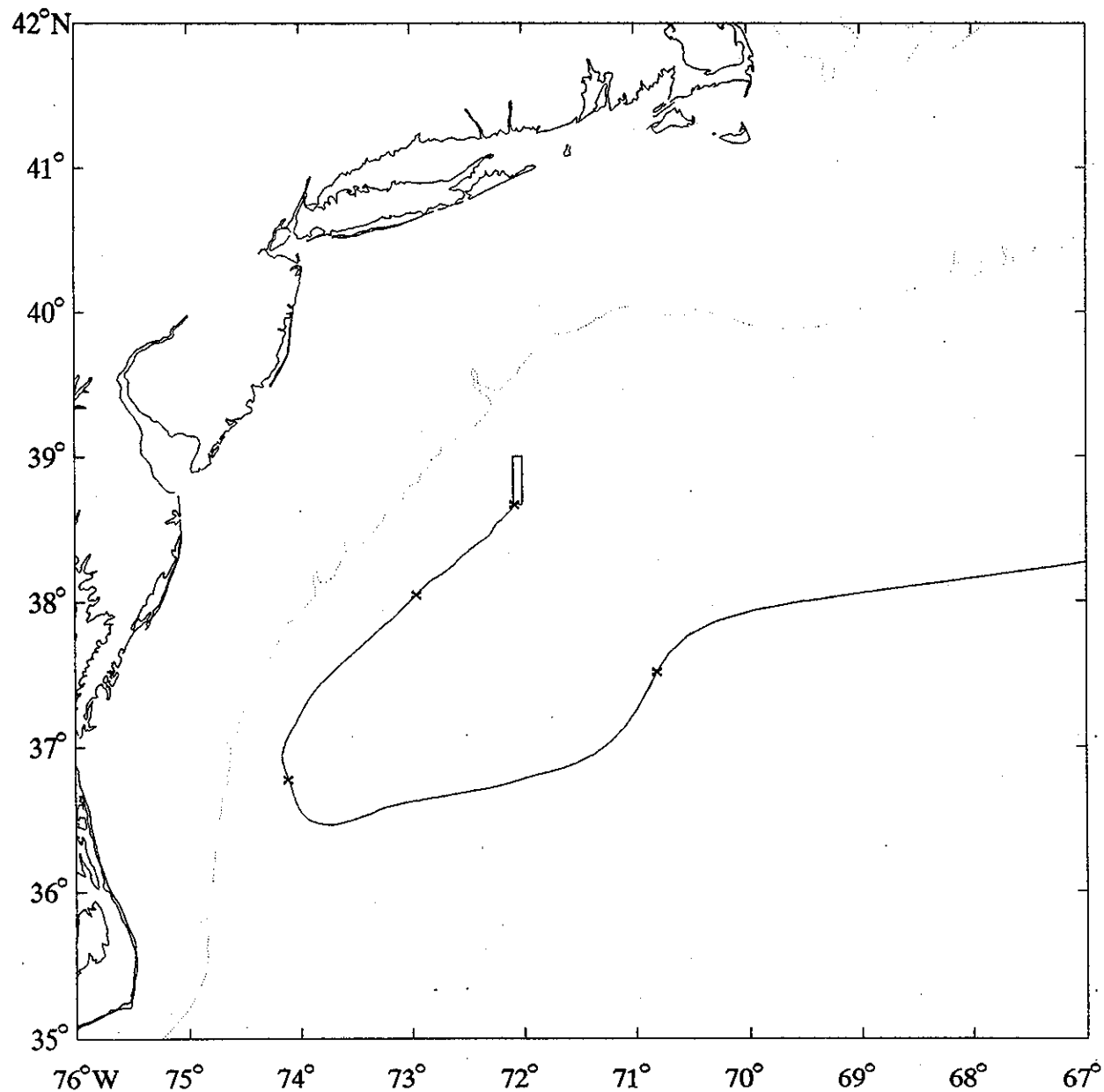


Figure A-21(a). Trajectory of Drifter Number 12741 Deployed on June 21, 1990.

The last transmission was on September 1, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-21(b). Trajectory of Drifter Number 12741 Deployed on June 21, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-66

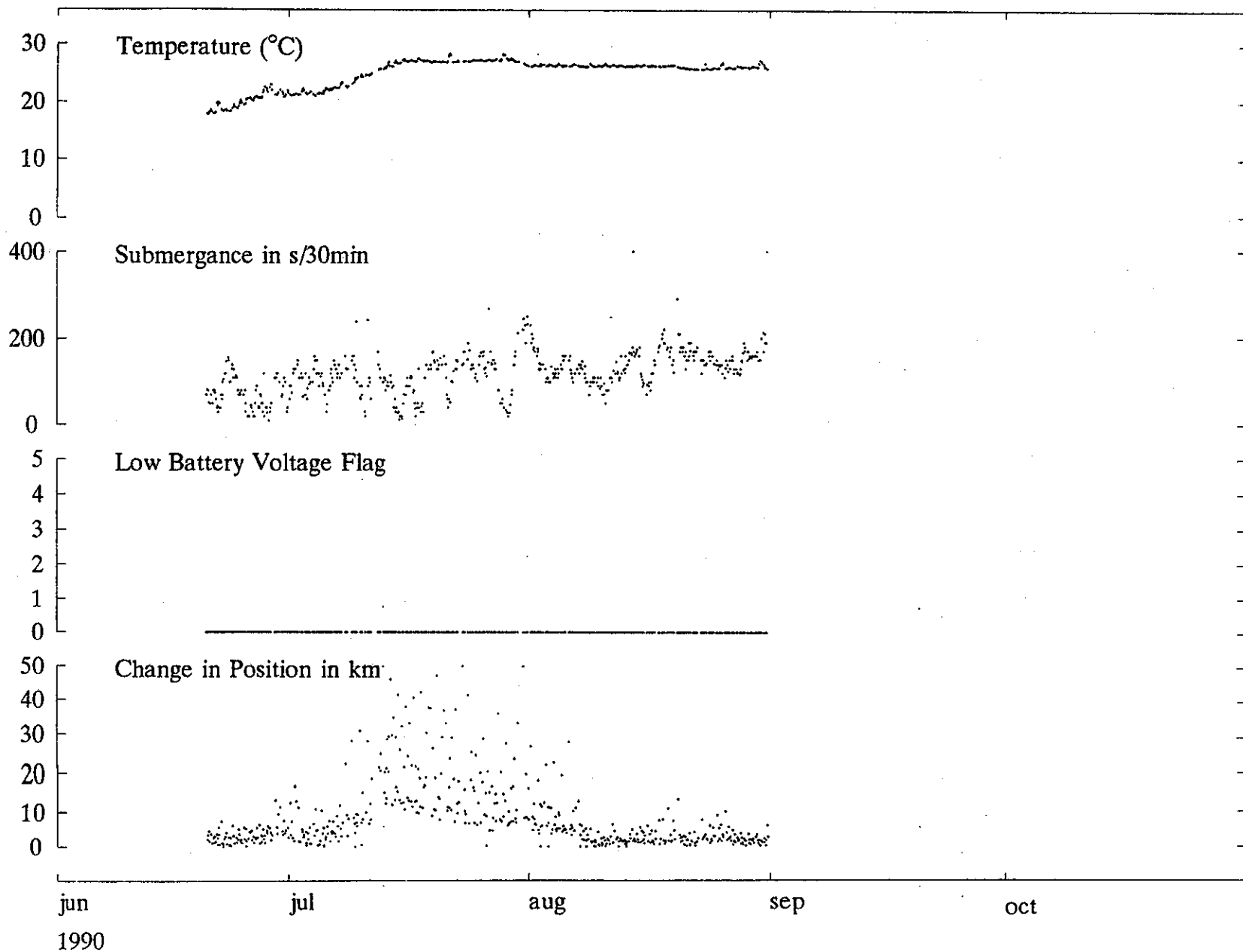


Figure A-21(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12741.

The data have been quality-assured, removing transmission errors and wild points.

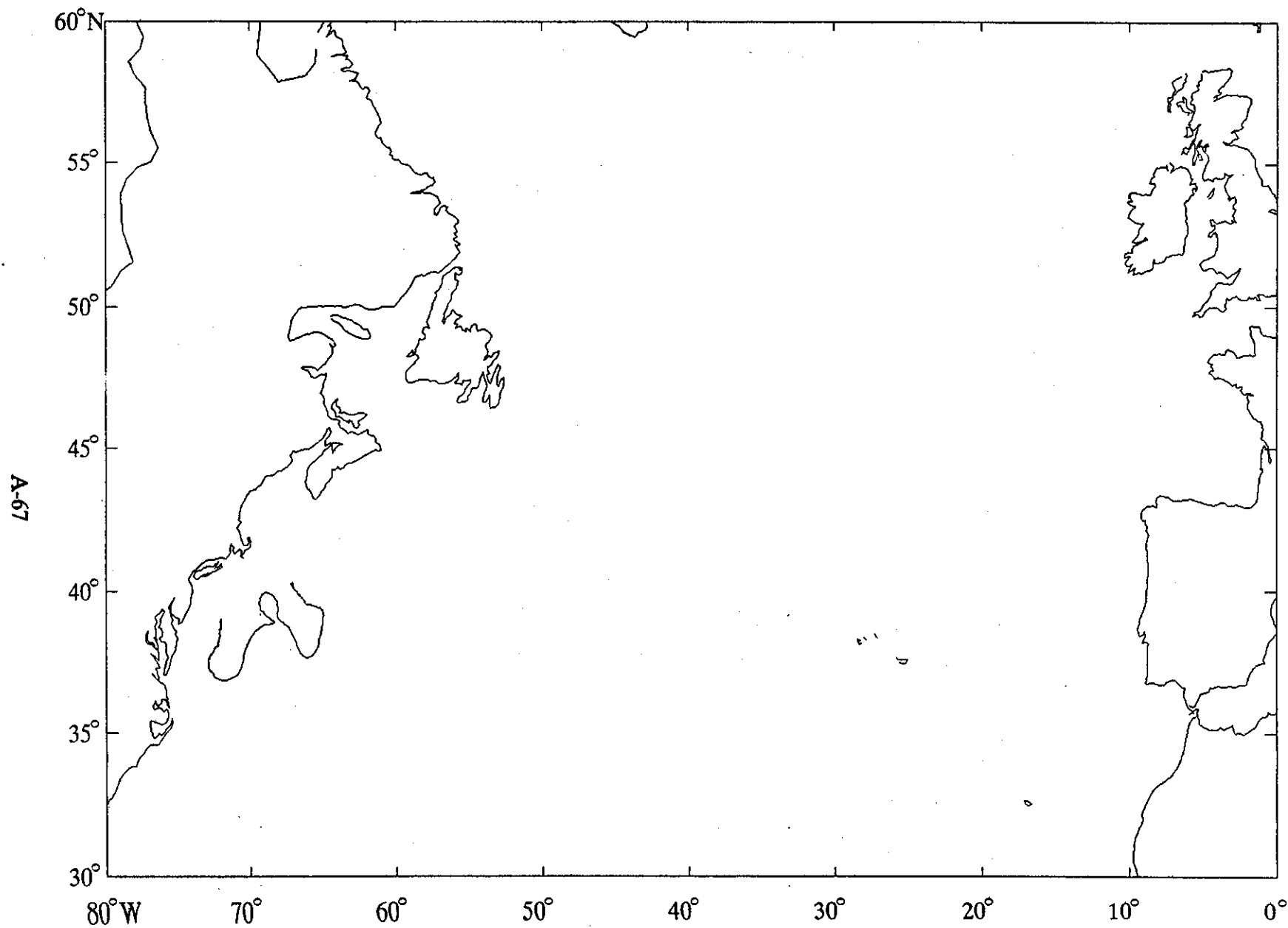
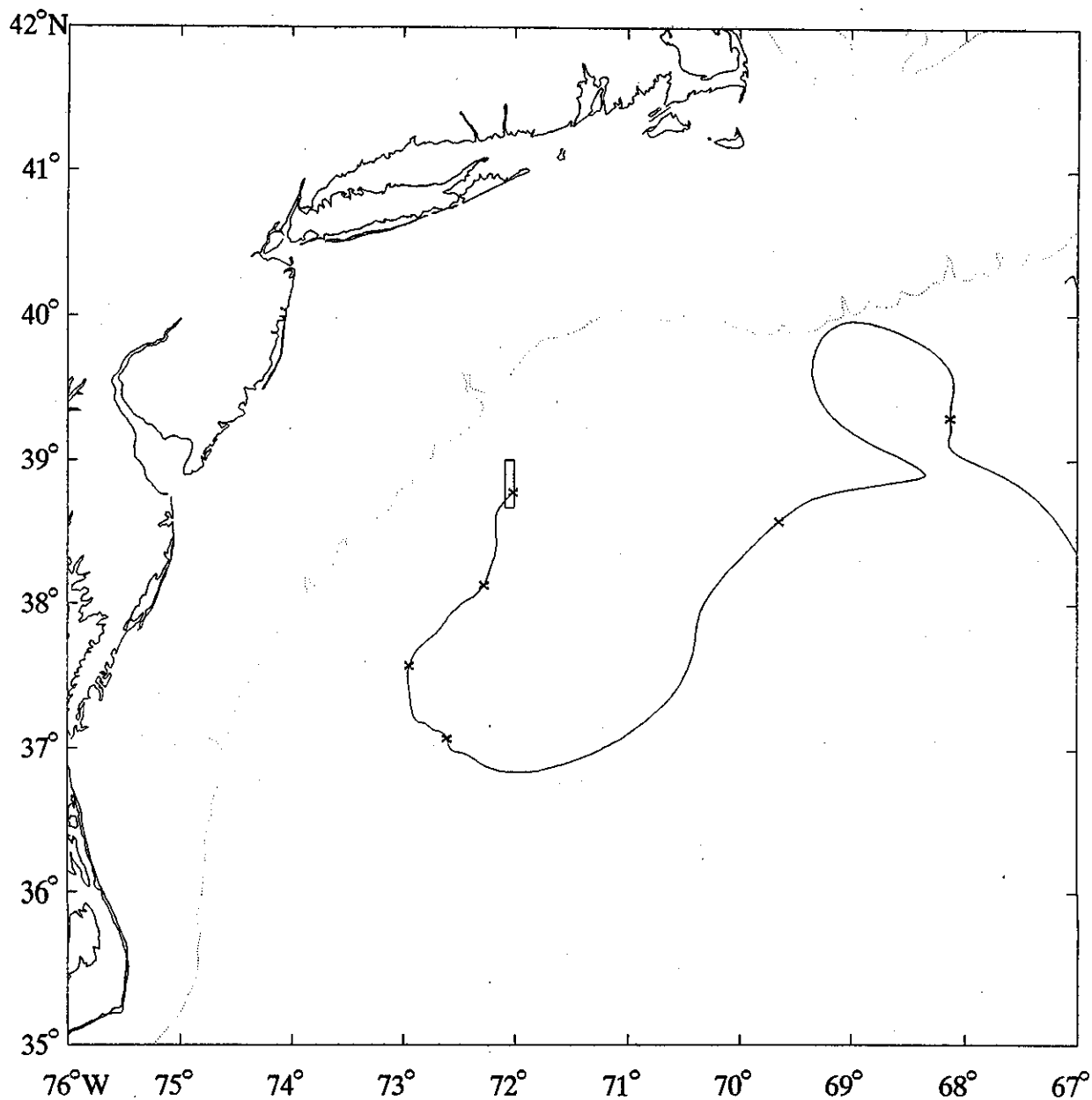


Figure A-22(a). Trajectory of Drifter Number 12742 Deployed on July 6, 1990.

The last transmission was on August 27, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-22(b). Trajectory of Drifter Number 12742 Deployed on July 6, 1990,
Shown in the Vicinity of the Middle Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-69

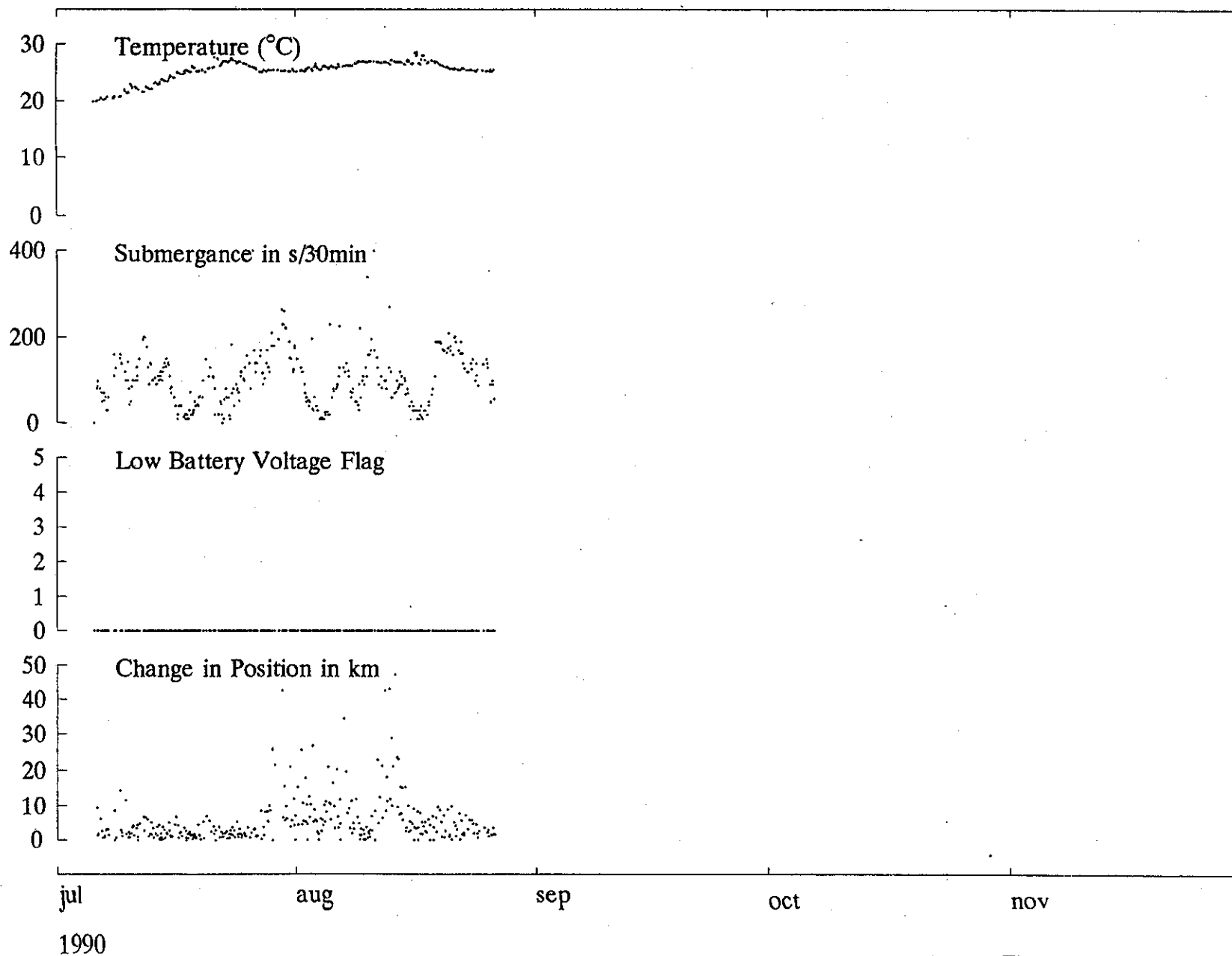


Figure A-22(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12742.

The data have been quality-assured, removing transmission errors and wild points.

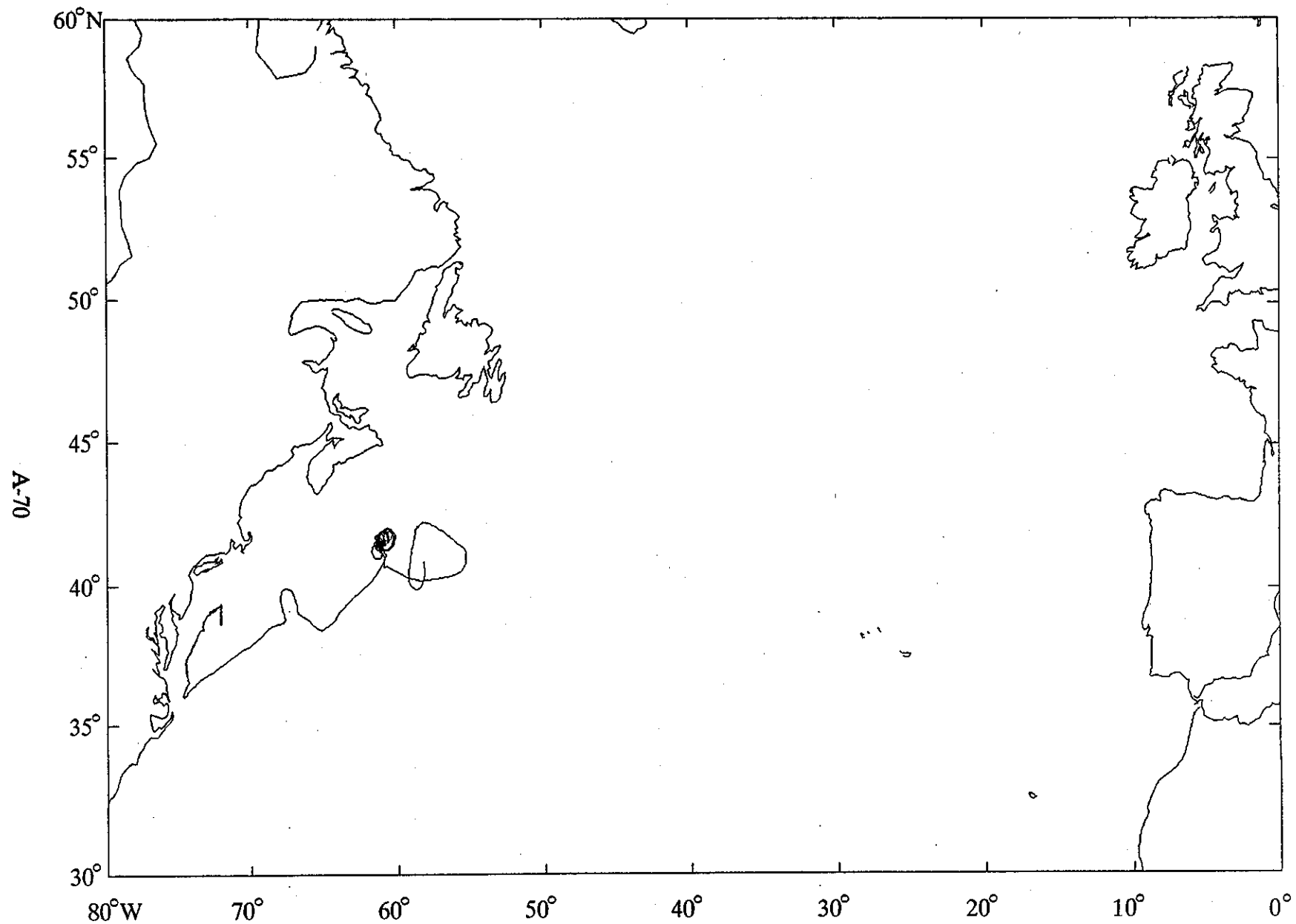
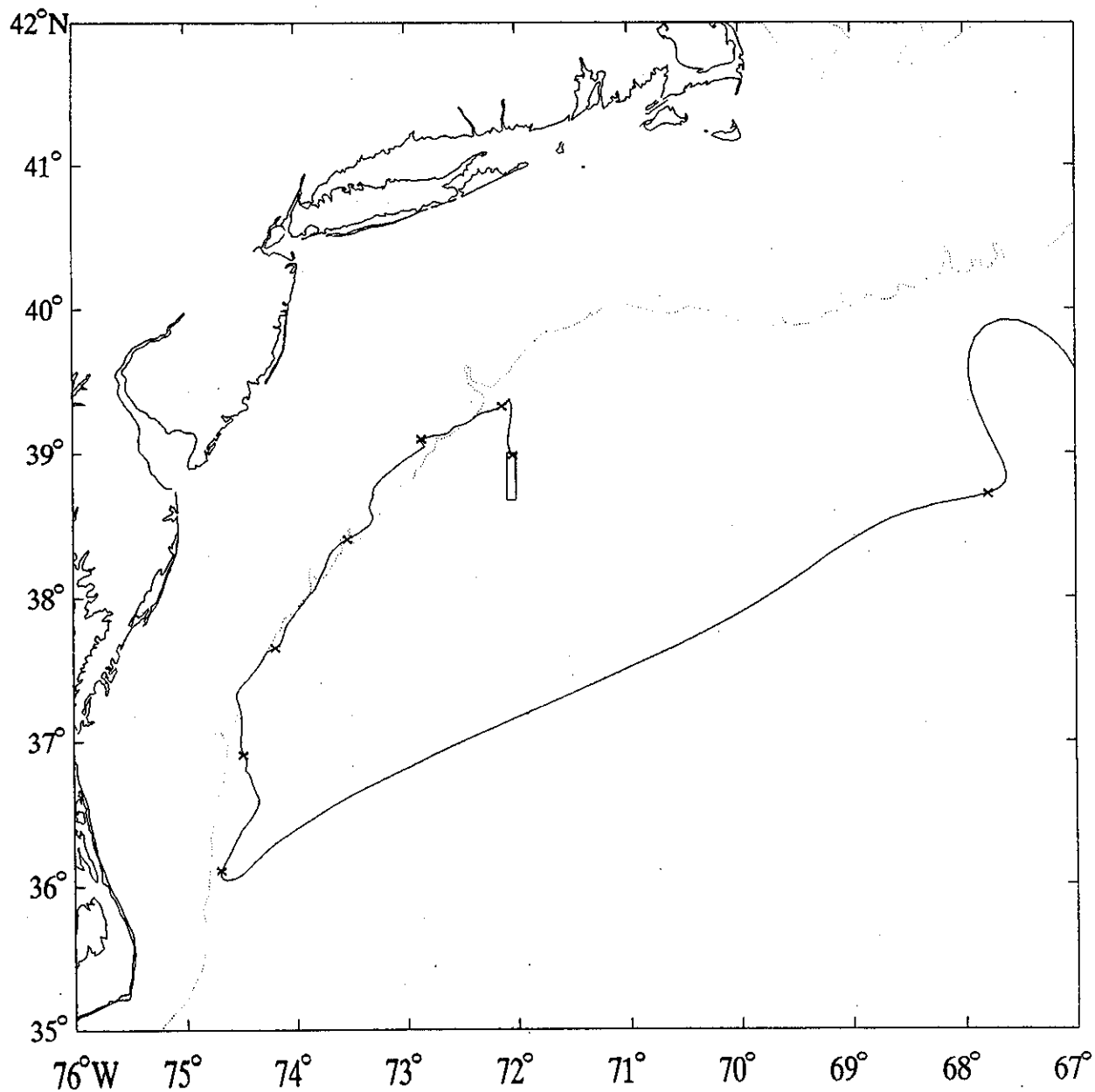


Figure A-23(a). Trajectory of Drifter Number 12744 Deployed on August 19, 1990.

The last transmission was on December 20, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-23(b). Trajectory of Drifter Number 12744 Deployed on August 19, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.
Crosses are evenly spaced at 7-day intervals.

A-72

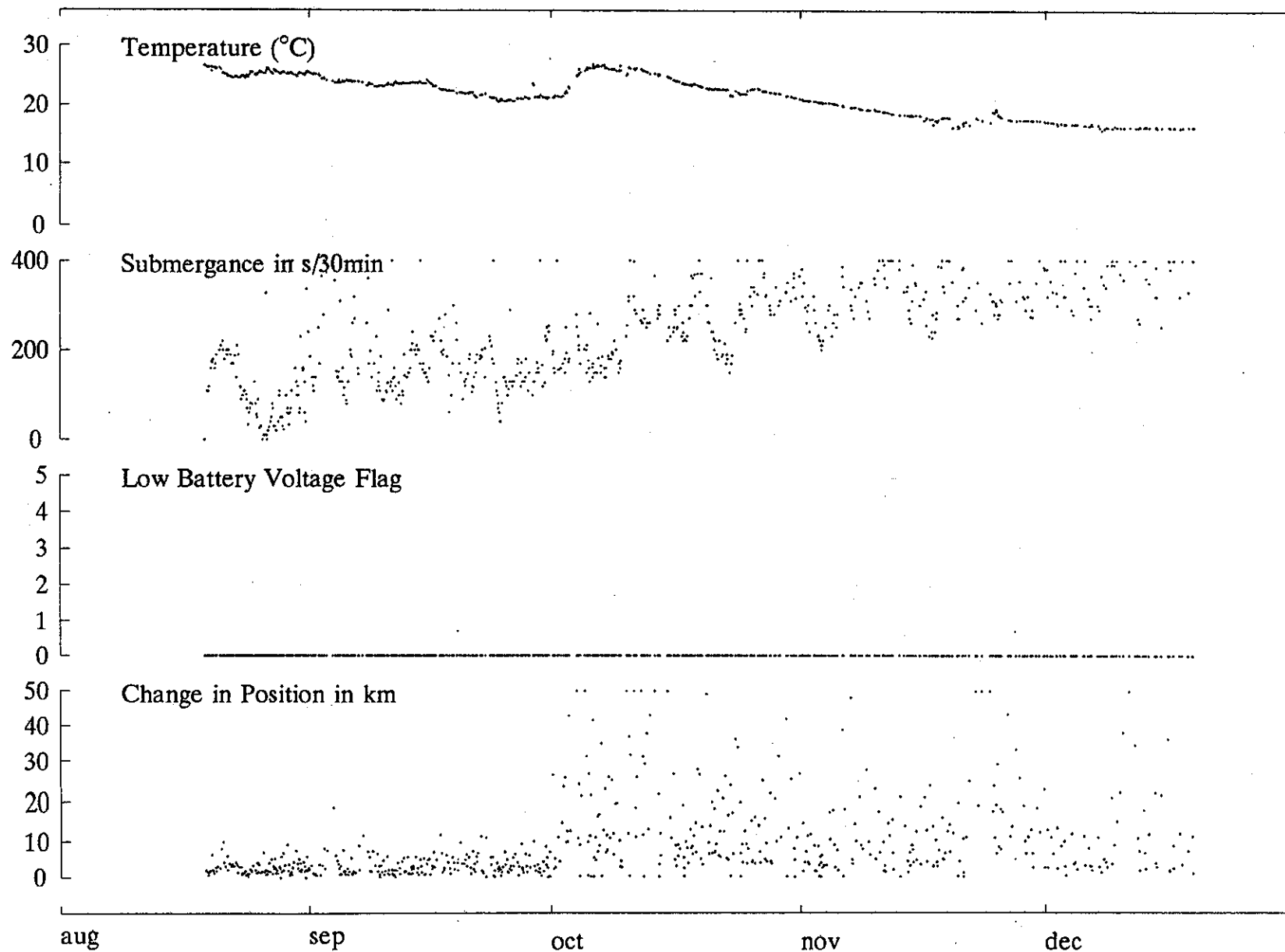


Figure A-23(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12744.

The data have been quality-assured, removing transmission errors and wild points.

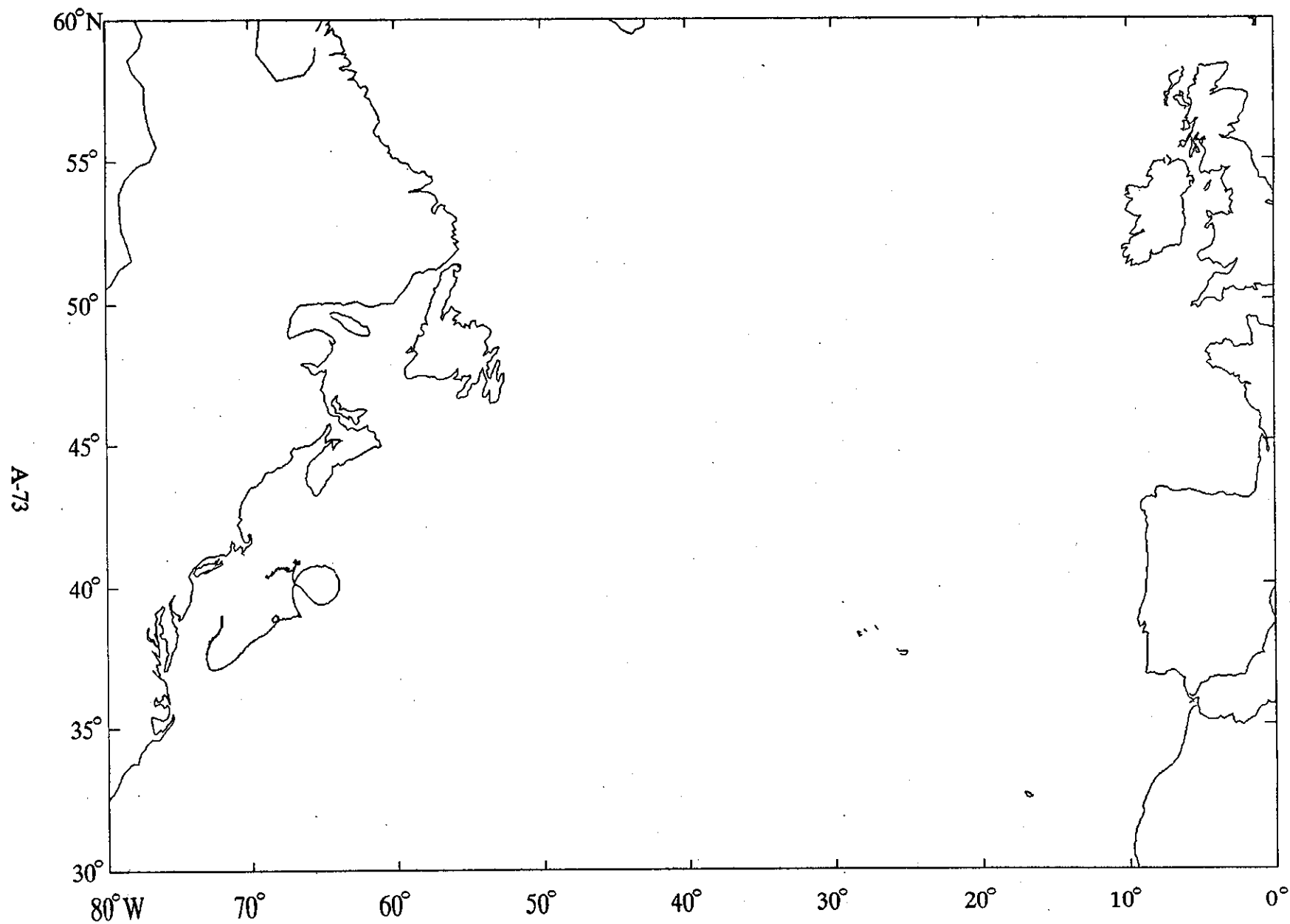
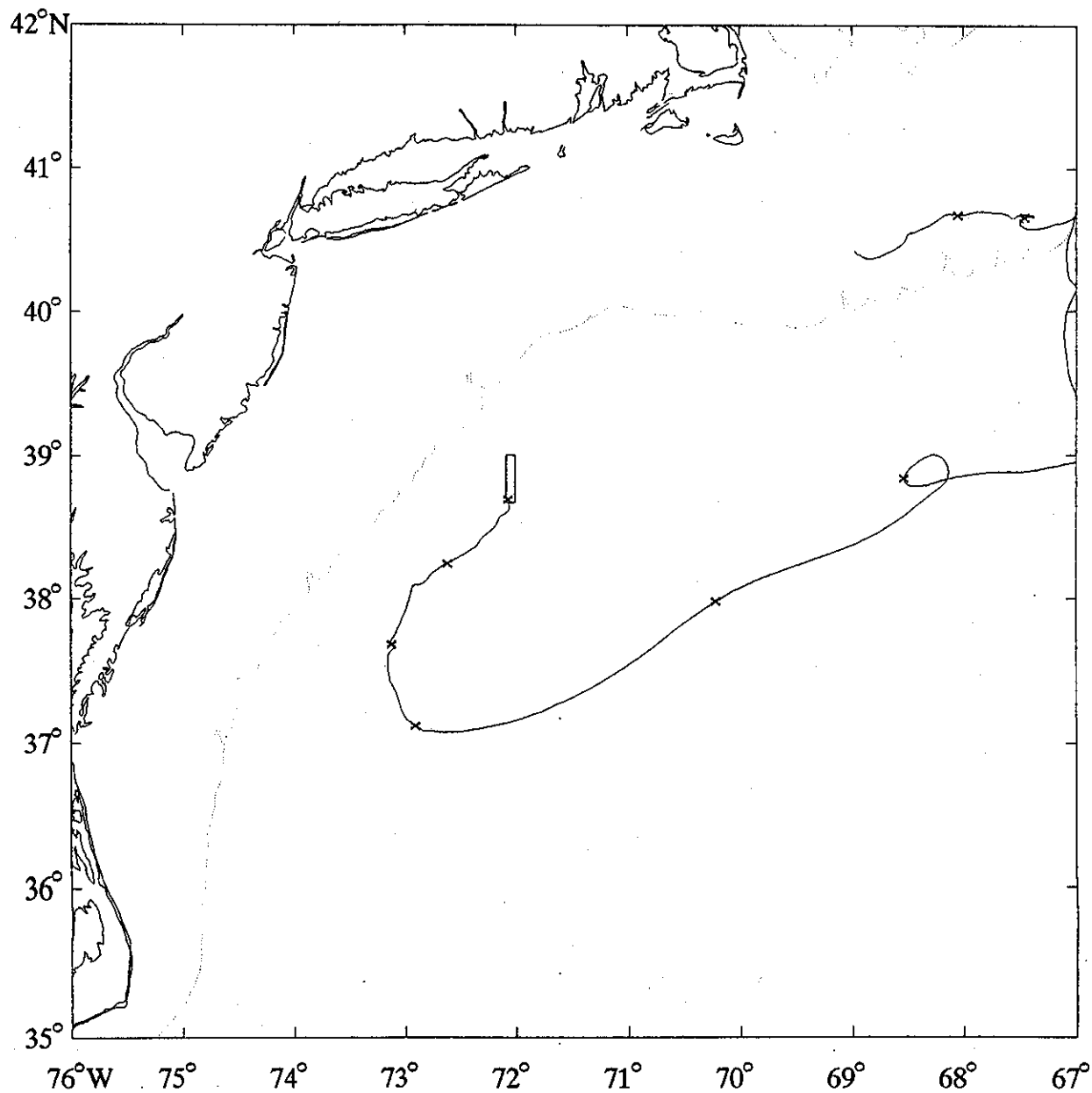


Figure A-24(a). Trajectory of Drifter Number 12745 Deployed on July 21, 1990.

The last transmission was on October 19, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-24(b). Trajectory of Drifter Number 12745 Deployed on July 21, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

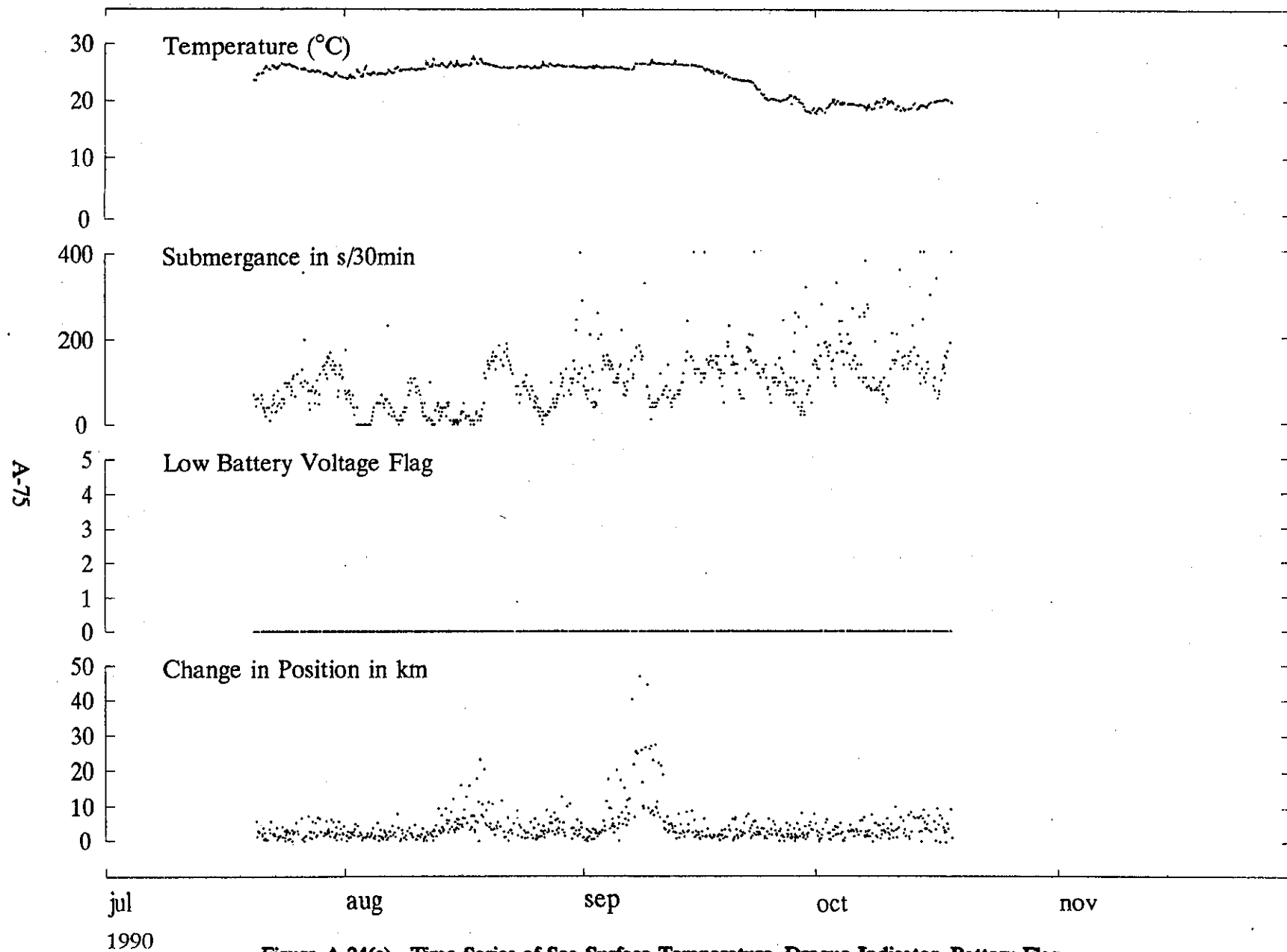


Figure A-24(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12745.

The data have been quality-assured, removing transmission errors and wild points.

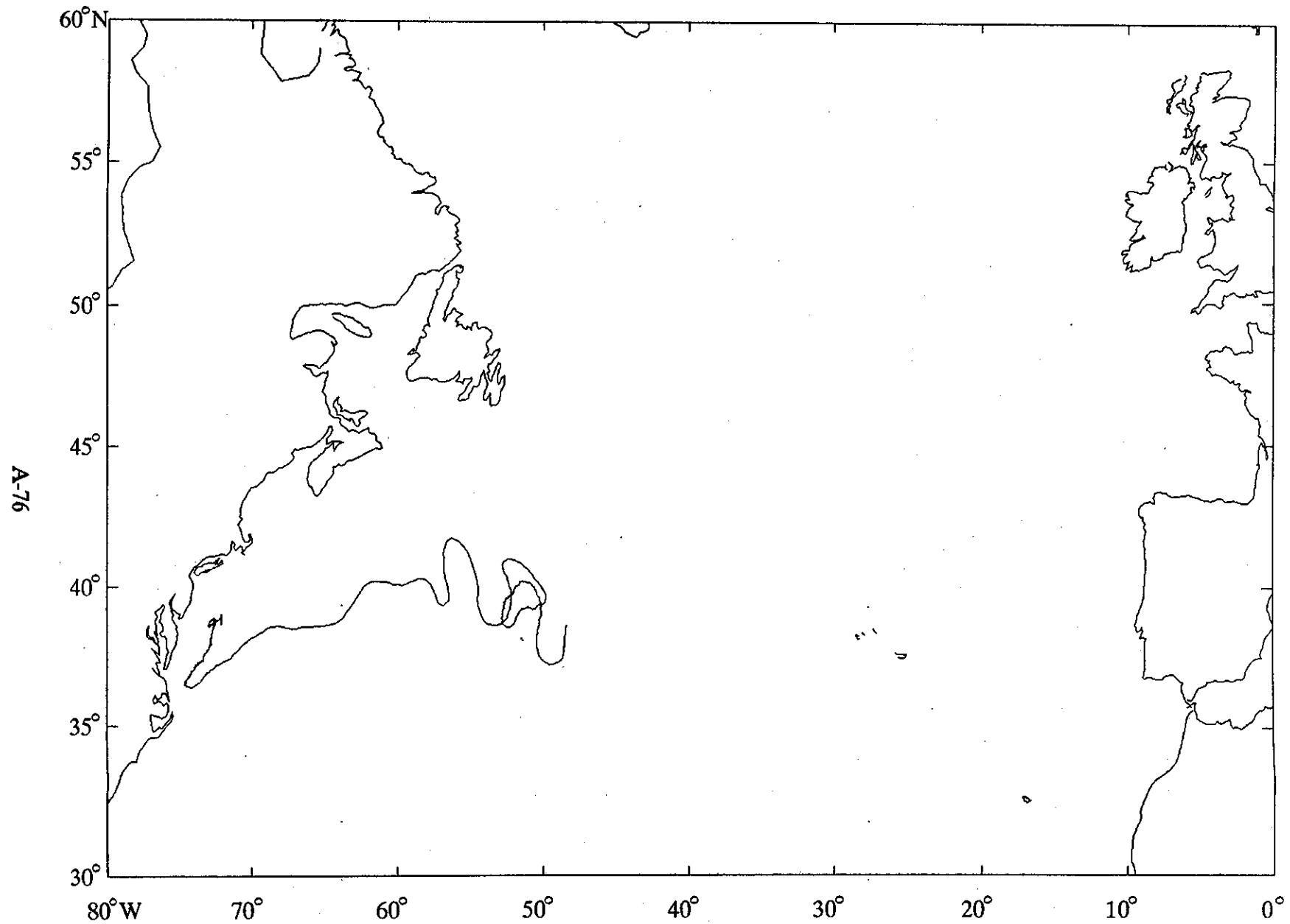
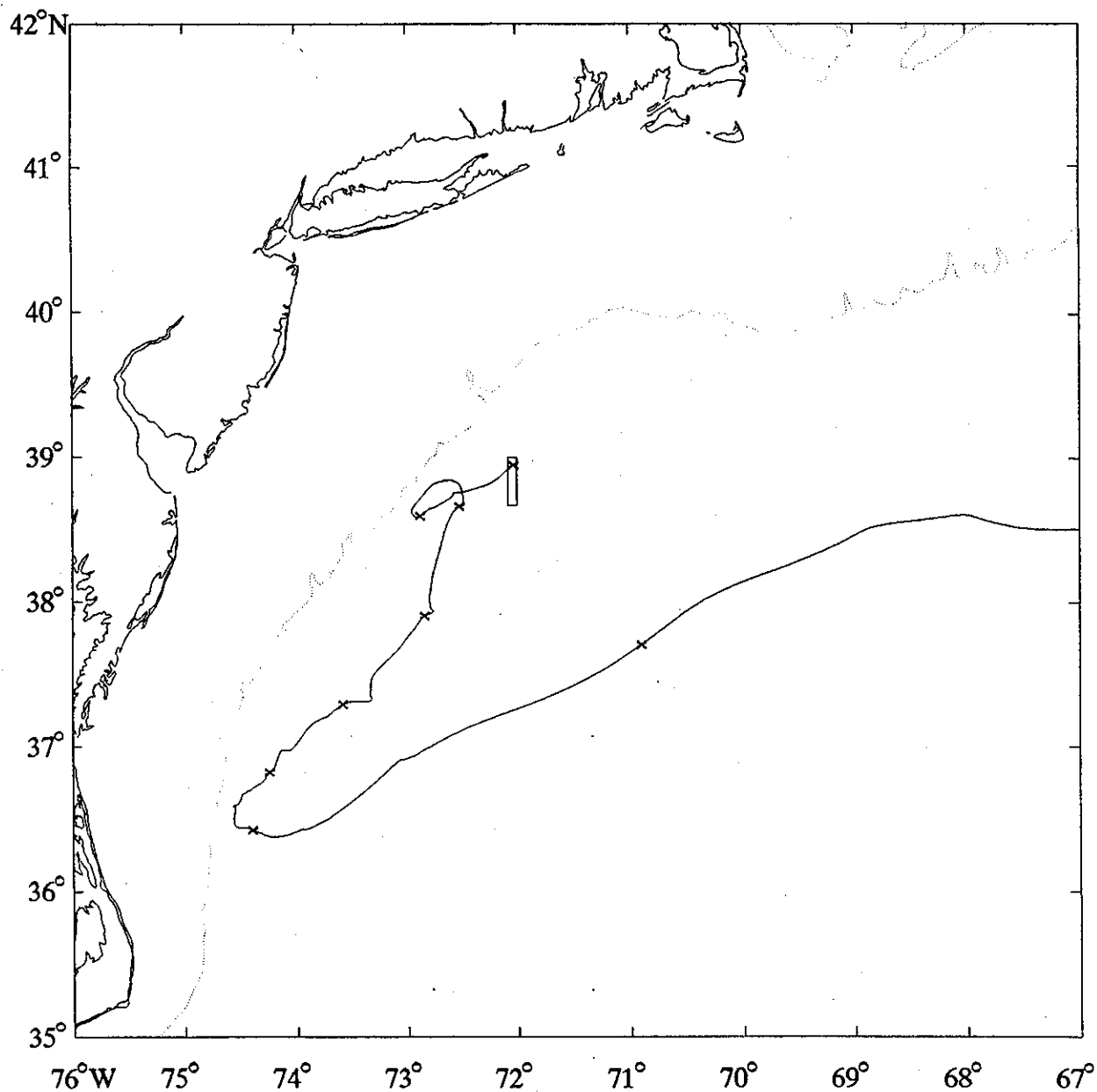


Figure A-25(a). Trajectory of Drifter Number 12747 Deployed on August 8, 1990.

The last transmission was on December 9, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-25(b). Trajectory of Drifter Number 12747 Deployed on August 8, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-78

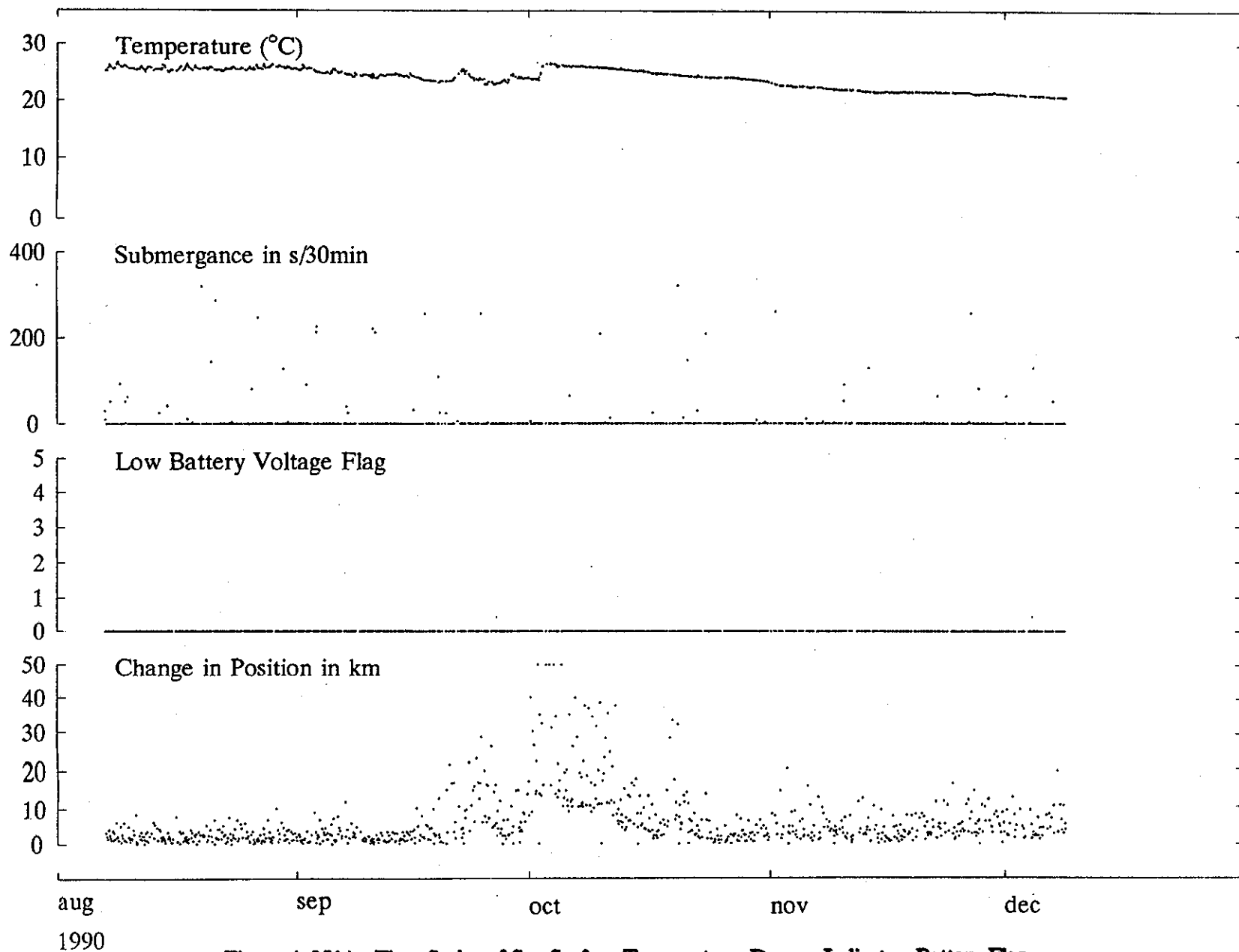


Figure A-25(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12747.

The data have been quality-assured, removing transmission errors and wild points.

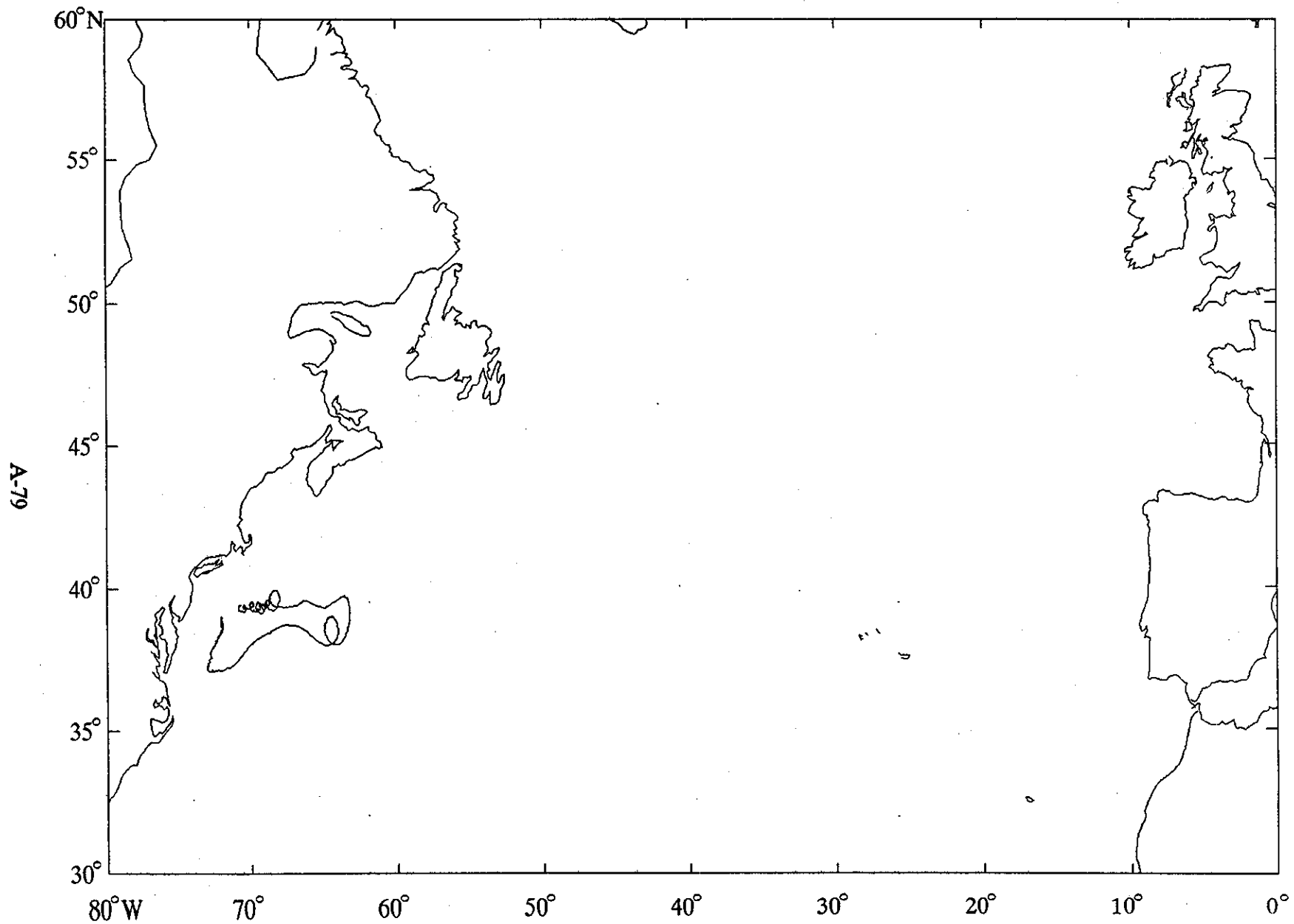
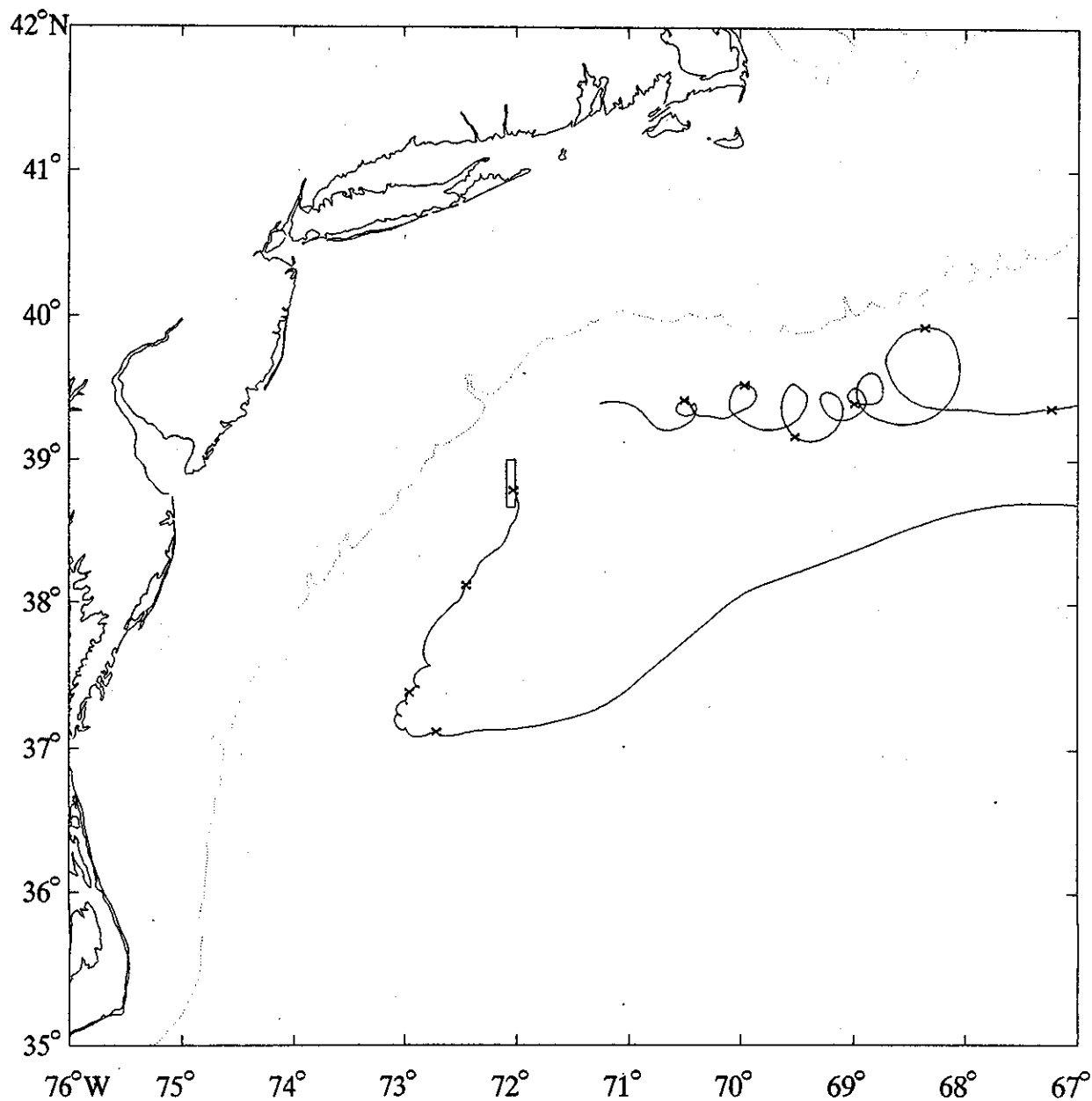


Figure A-26(a). Trajectory of Drifter Number 12748 Deployed on July 26, 1990.

The last transmission was on October 21, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-26(b). Trajectory of Drifter Number 12748 Deployed on July 26, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

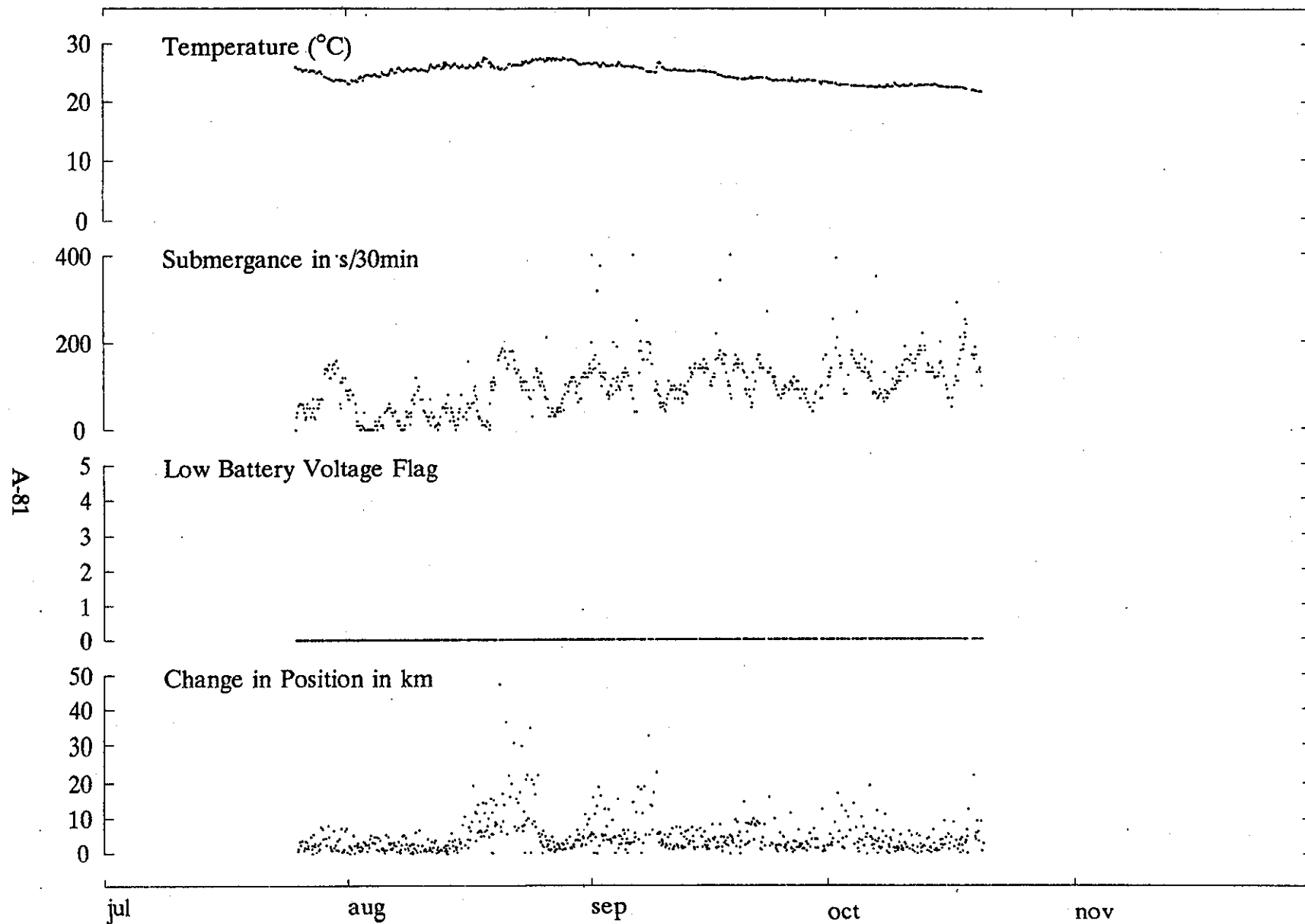


Figure A-26(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12748.

The data have been quality-assured, removing transmission errors and wild points.

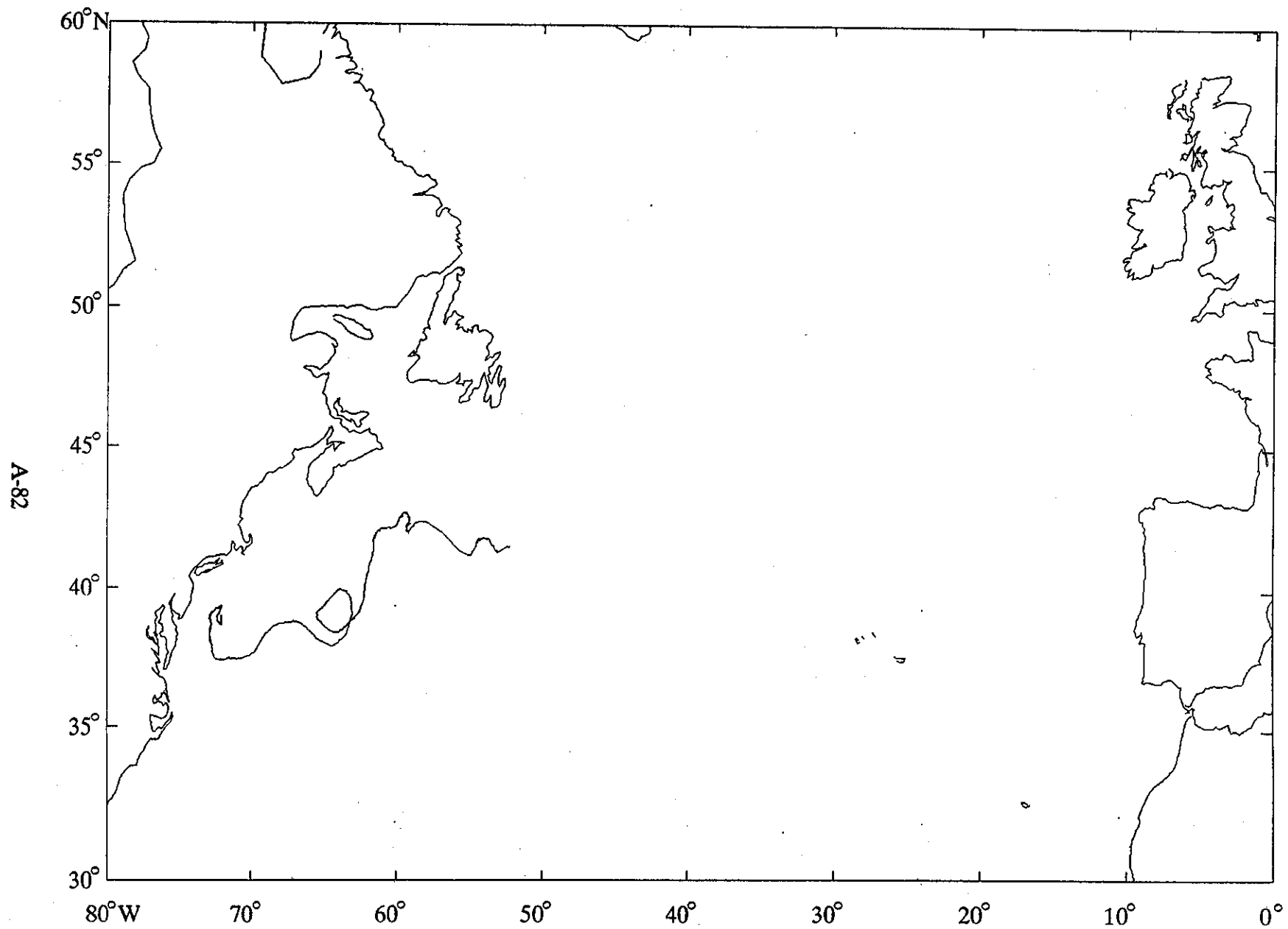
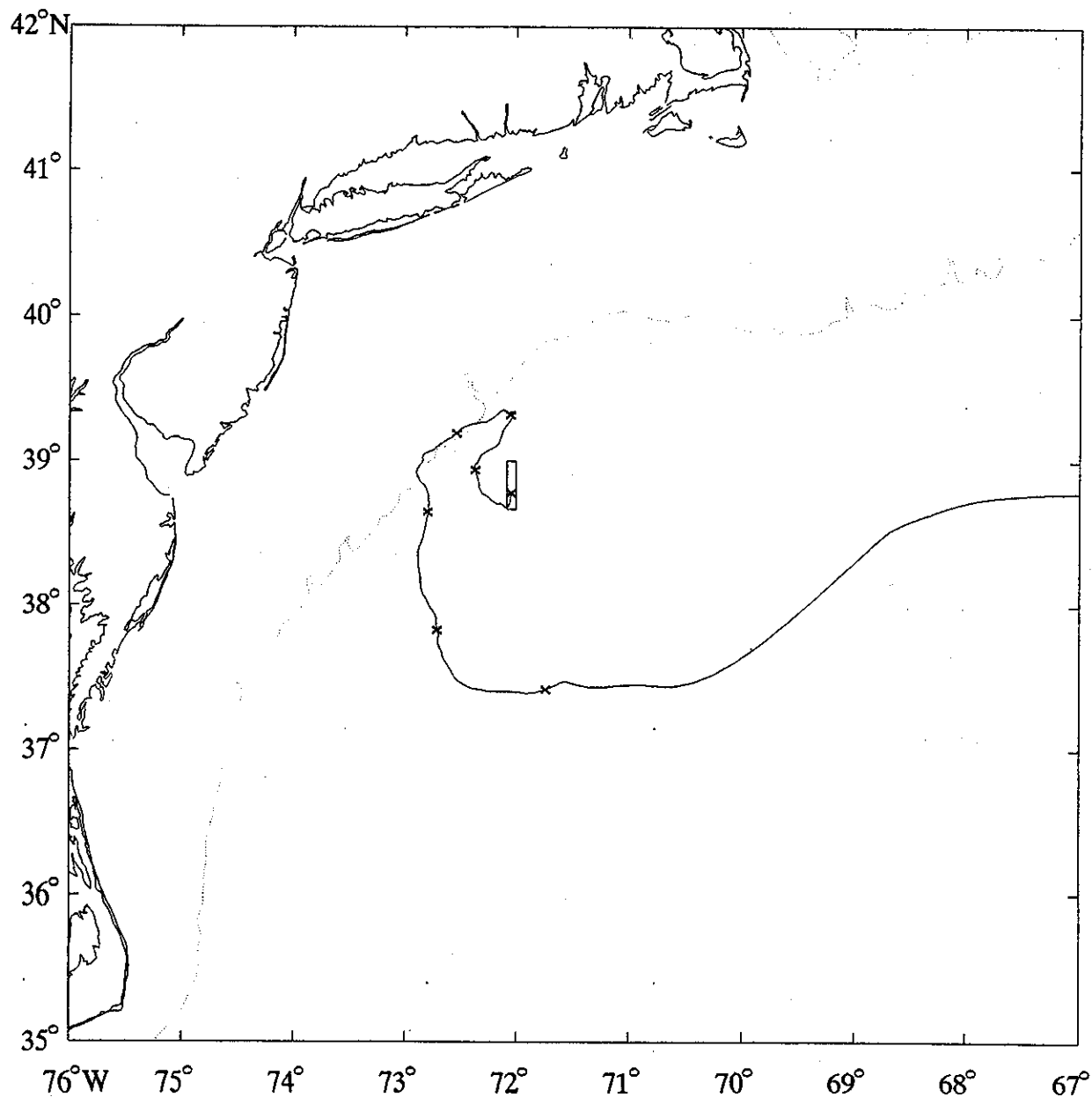


Figure A-27(a). Trajectory of Drifter Number 12749 Deployed on July 11, 1990.

The last Transmission was on November 12, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-27(b). Trajectory of Drifter Number 12749 Deployed on July 11, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-84

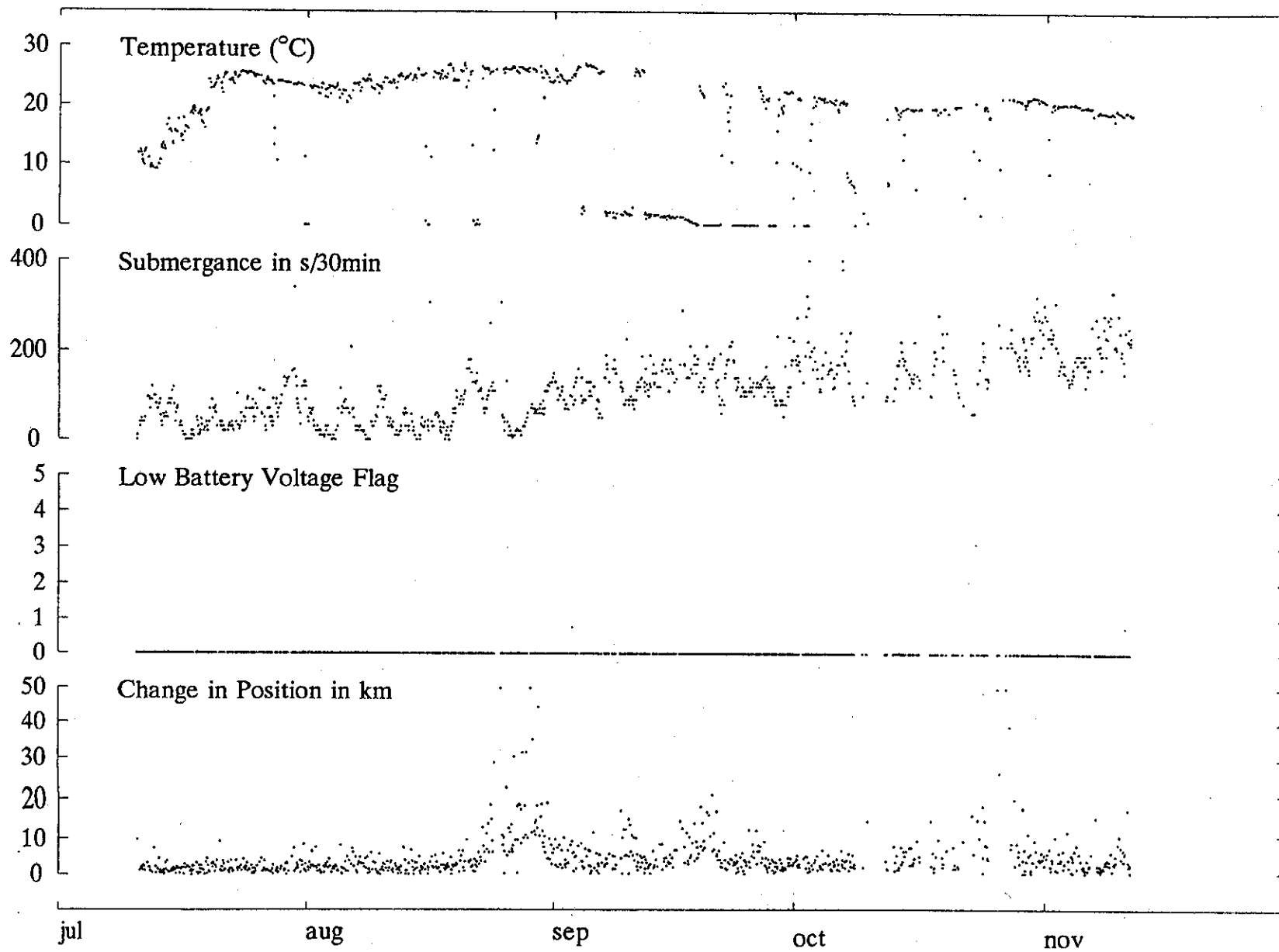


Figure A-27(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12749.

The data have been quality-assured, removing transmission errors and wild points.

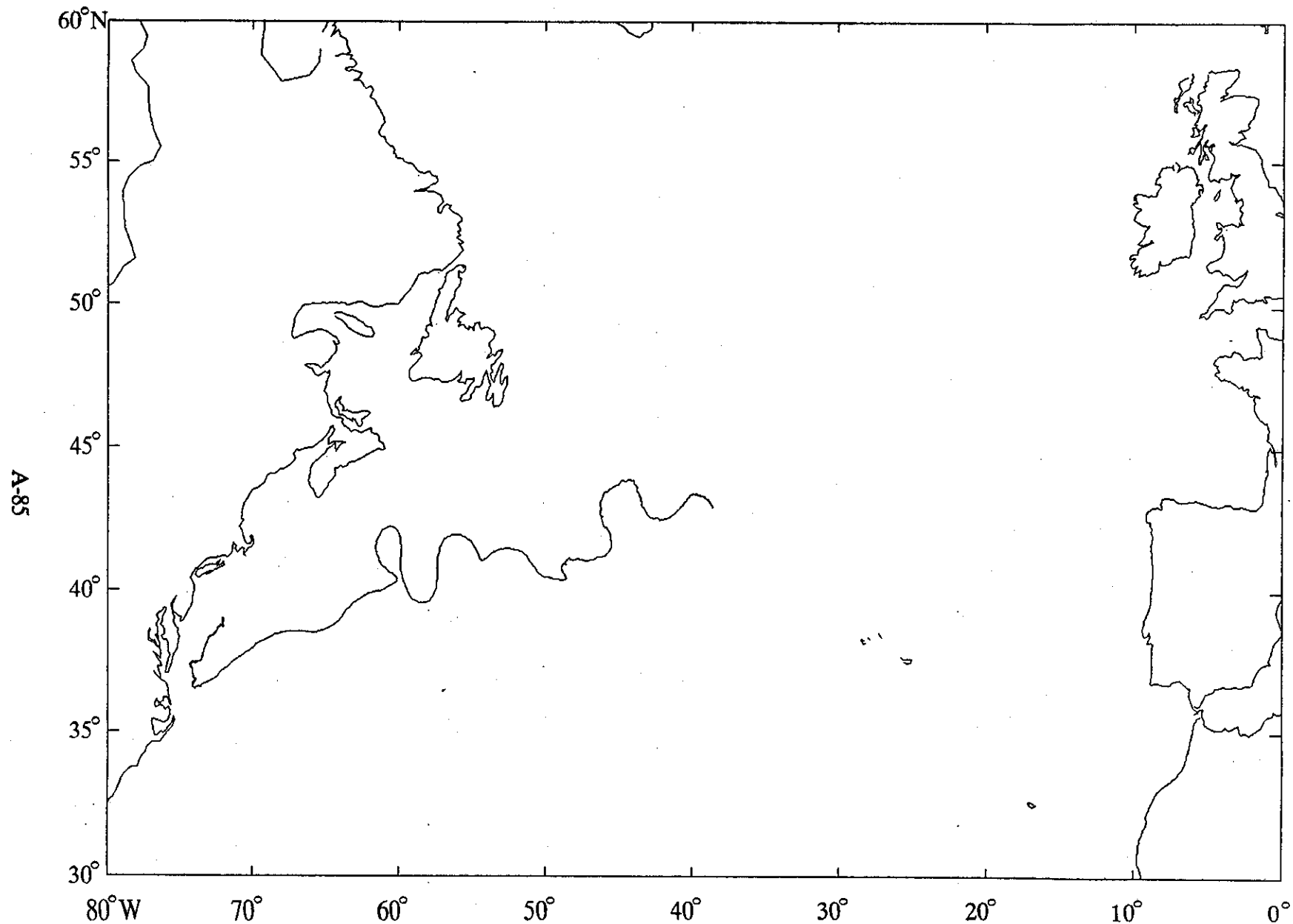
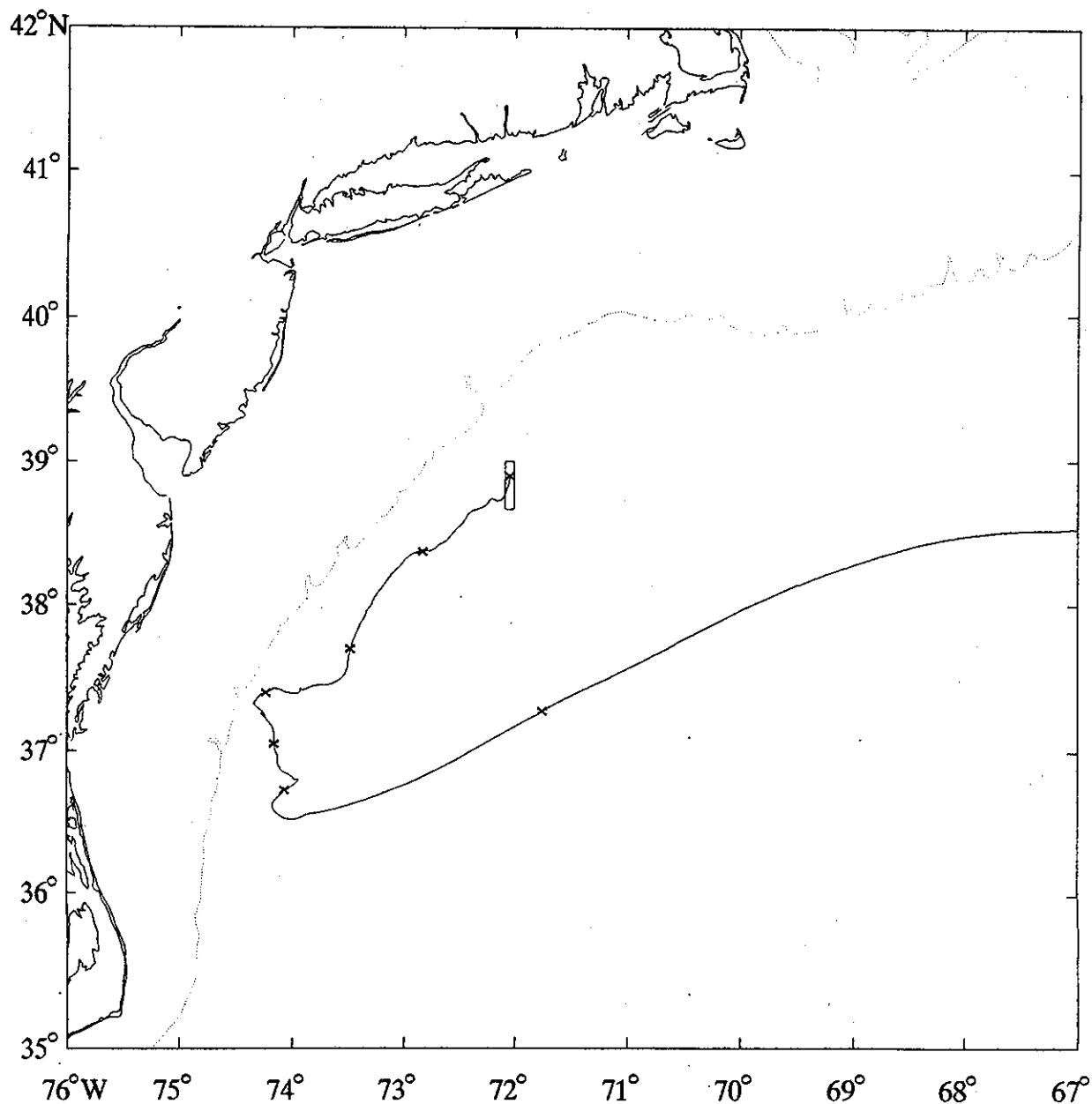


Figure A-28(a). Trajectory of Drifter Number 12751 Deployed on August 15, 1990.

The last transmission was on December 3, 1990.

The trajectory has been smoothed with a 2-day low-pass filter.



**Figure A-28(b). Trajectory of Drifter Number 12751 Deployed on August 15, 1990,
Shown in the Vicinity of the Mid-Atlantic Bight.**

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are evenly spaced at 7-day intervals.

The trajectory has been smoothed with a 2-day low-pass filter.

A-87

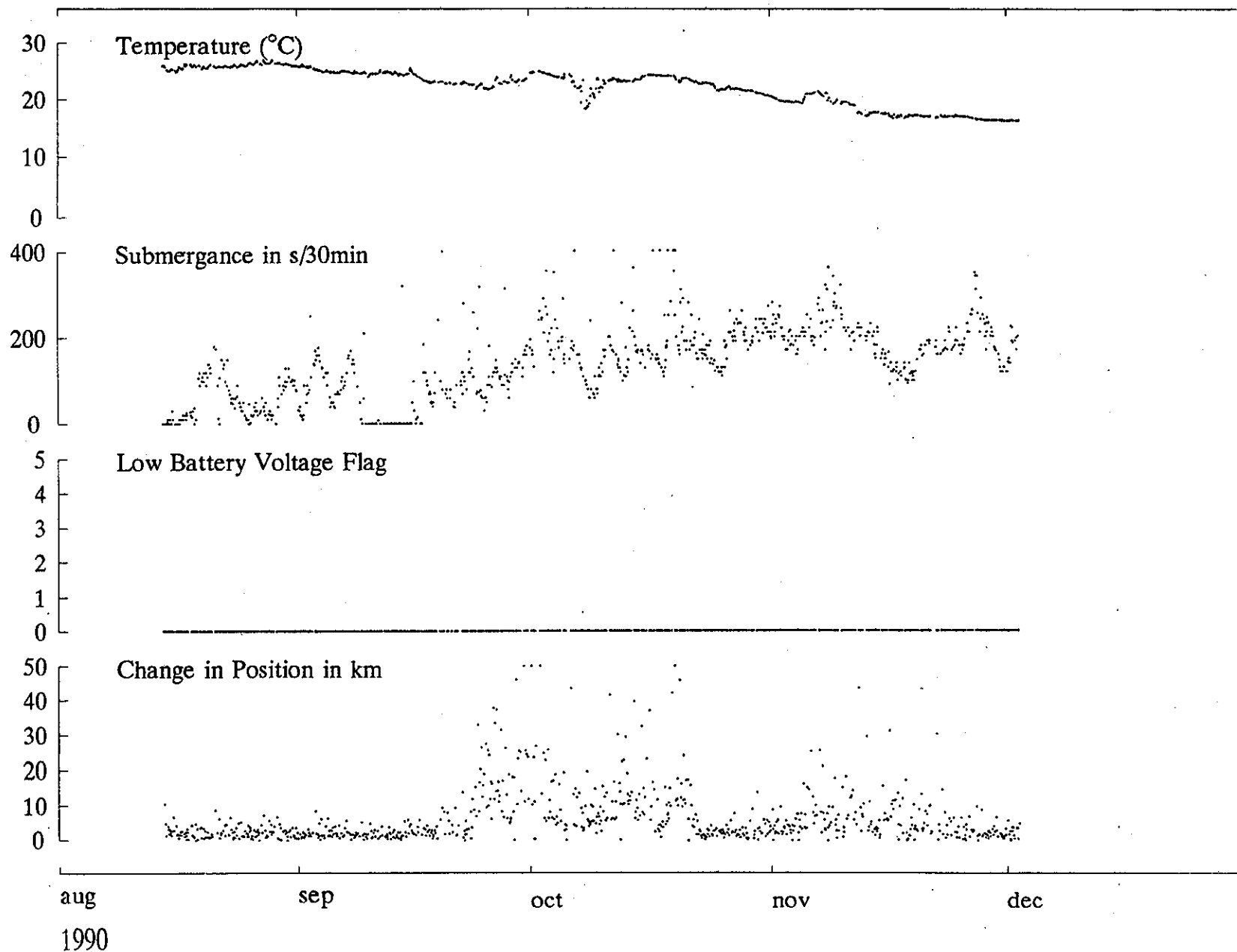


Figure A-28(c). Time Series of Sea Surface Temperature, Drogue Indicator, Battery Flag, and Change in Position for Drifter Number 12751.

The data have been quality-assured, removing transmission errors and wild points.

APPENDIX AA DRIFTER DATA

This appendix presents only those data from drifters still transmitting on or deployed after December 31, 1990.

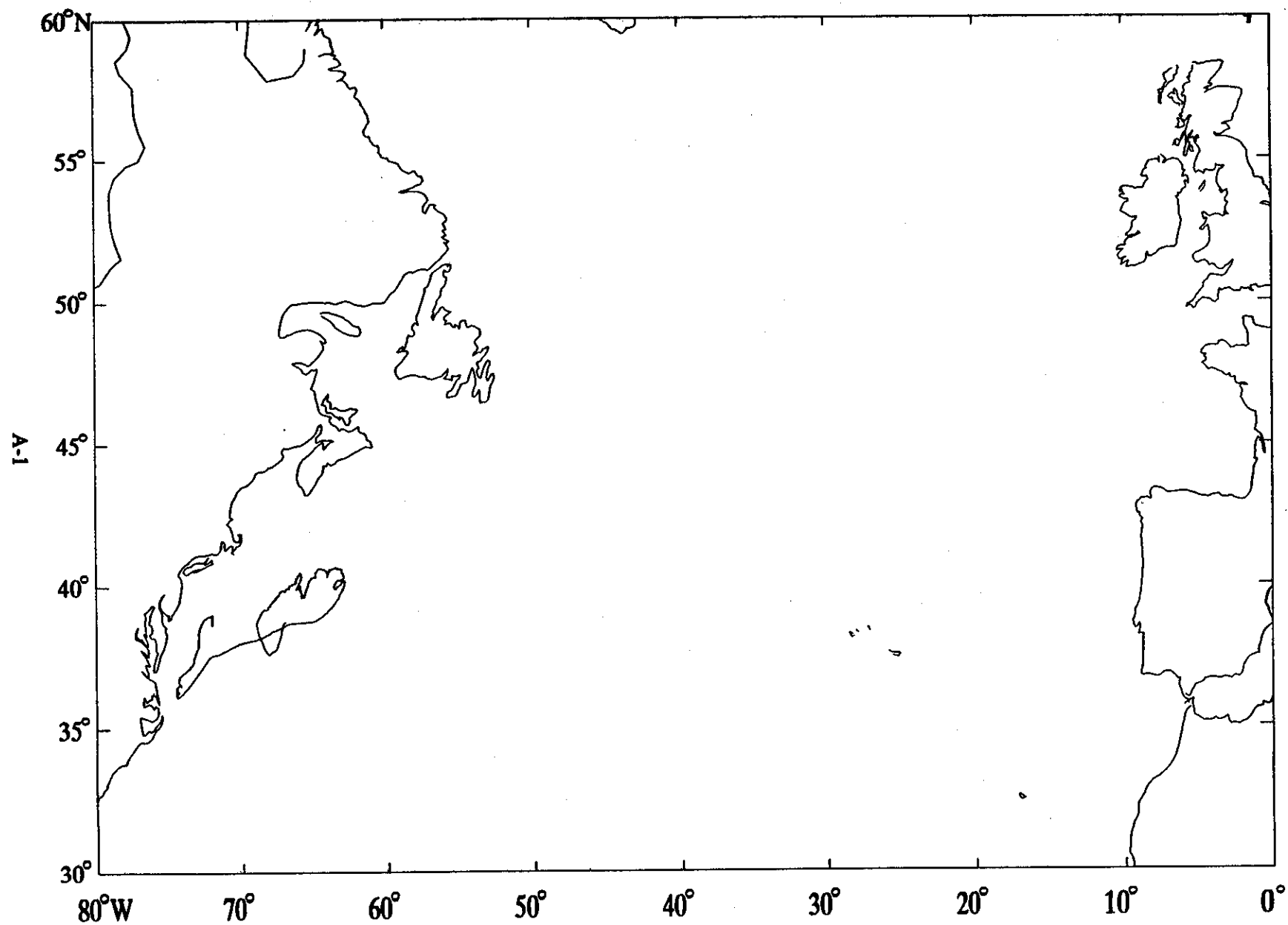


Figure A-1(a). Trajectory of drifter number 12743 deployed on October 31, 1990.
Last transmission received on February 27, 1991.

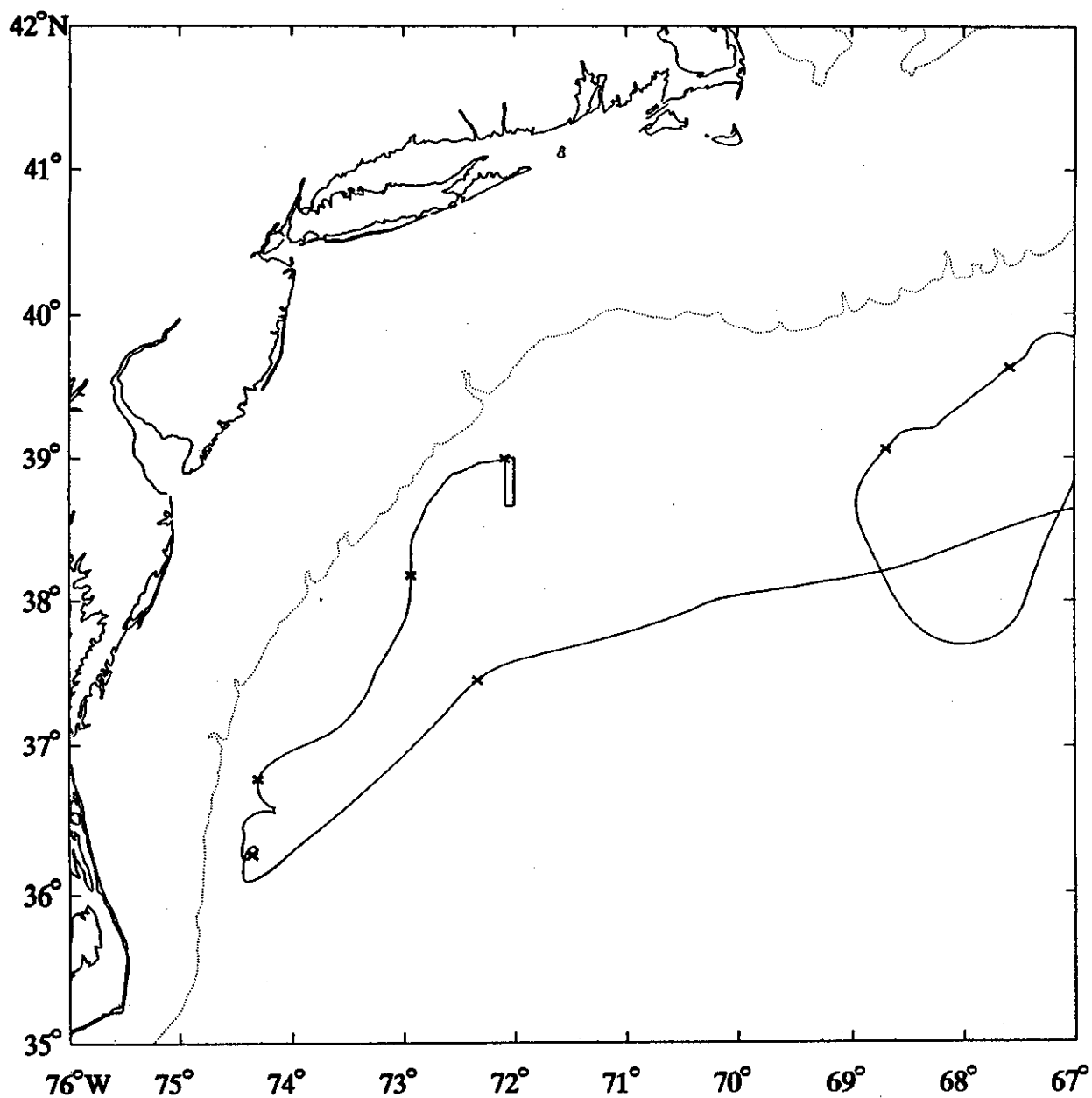


Figure A-1(b). Trajectory of drifter number 12743 deployed on October 31, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

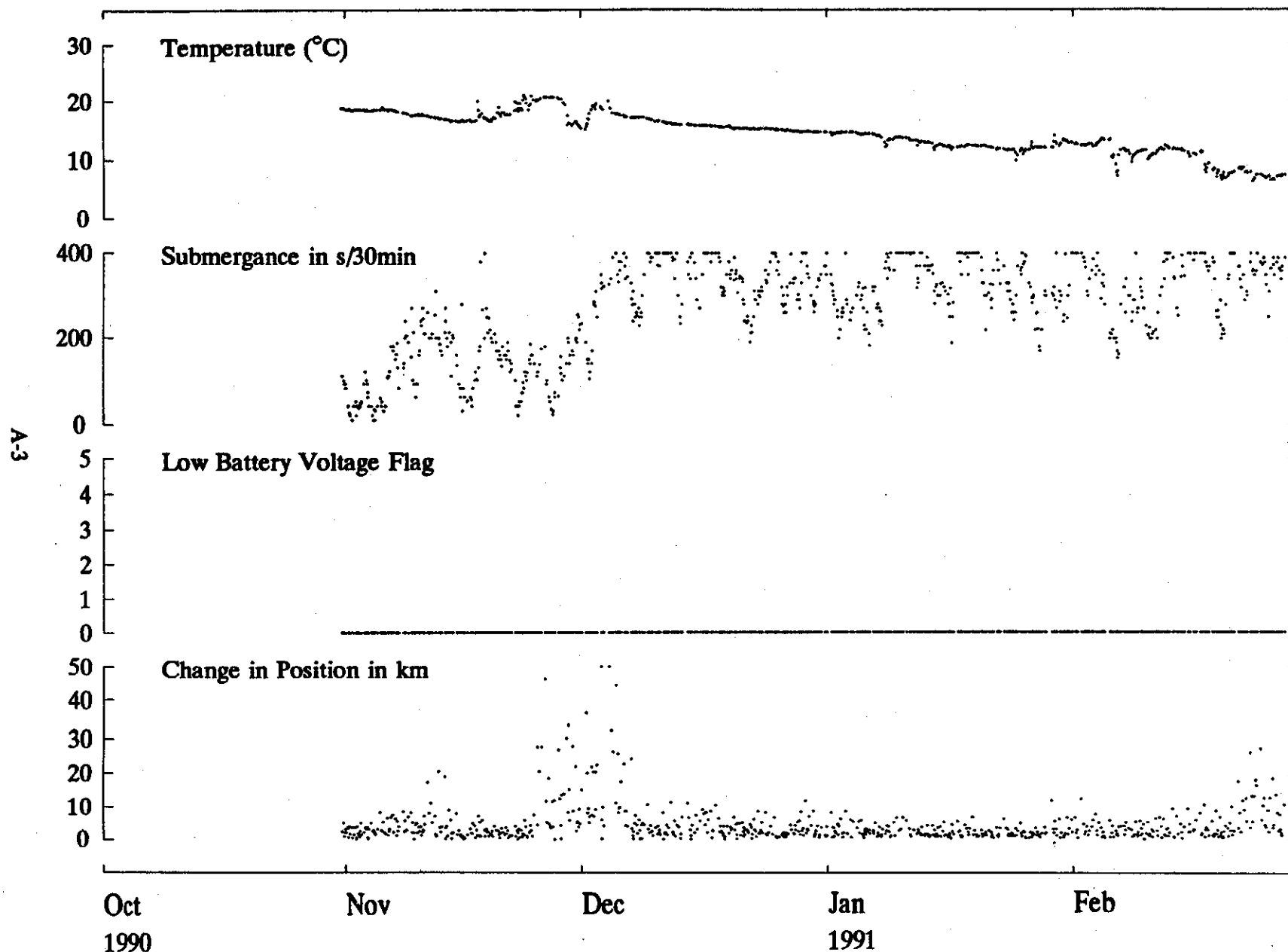
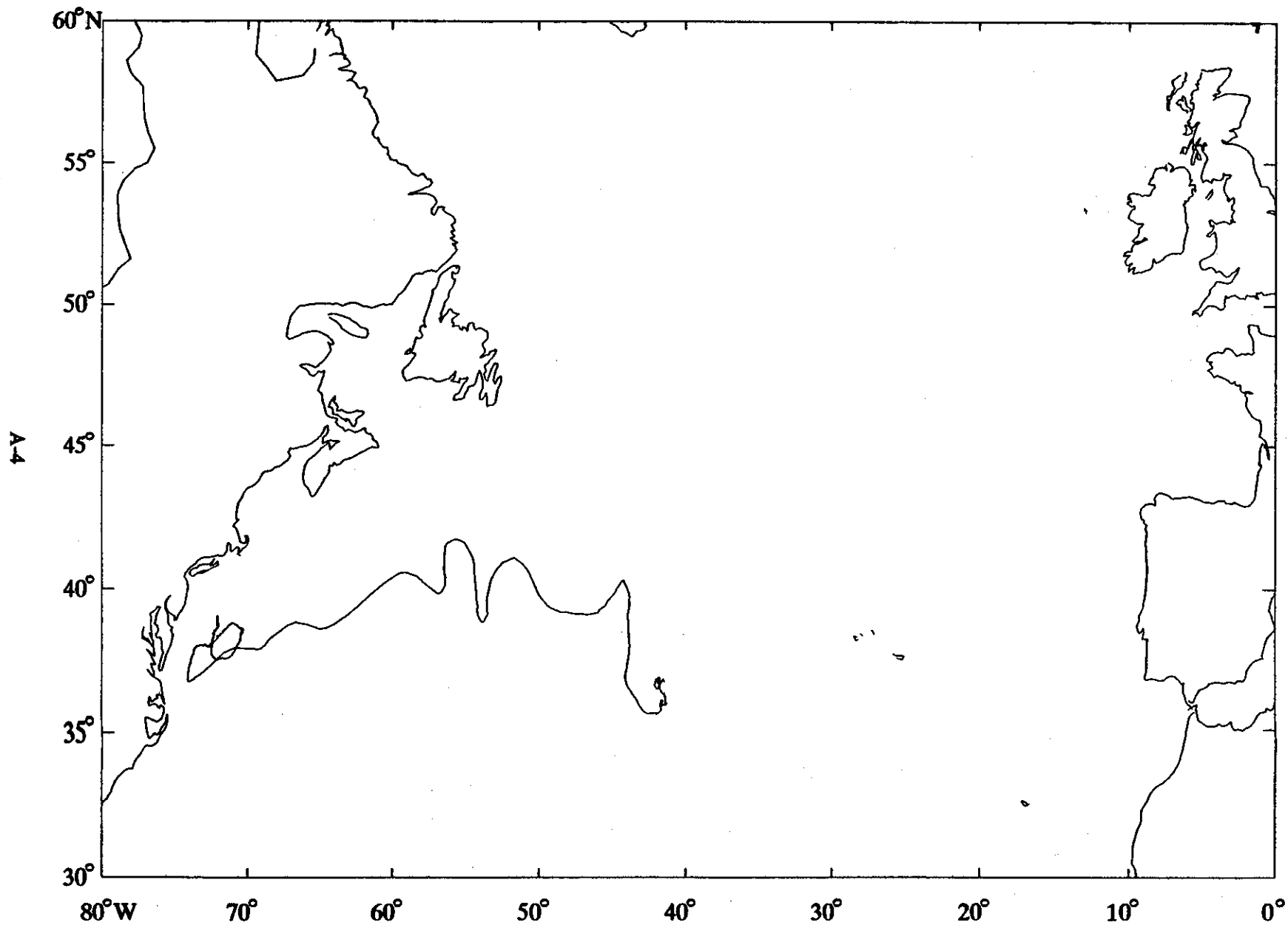


Figure A-1(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12743. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-2(a). Trajectory of drifter number 12746 deployed on September 19, 1990.
Last transmission received on January 20, 1991.**

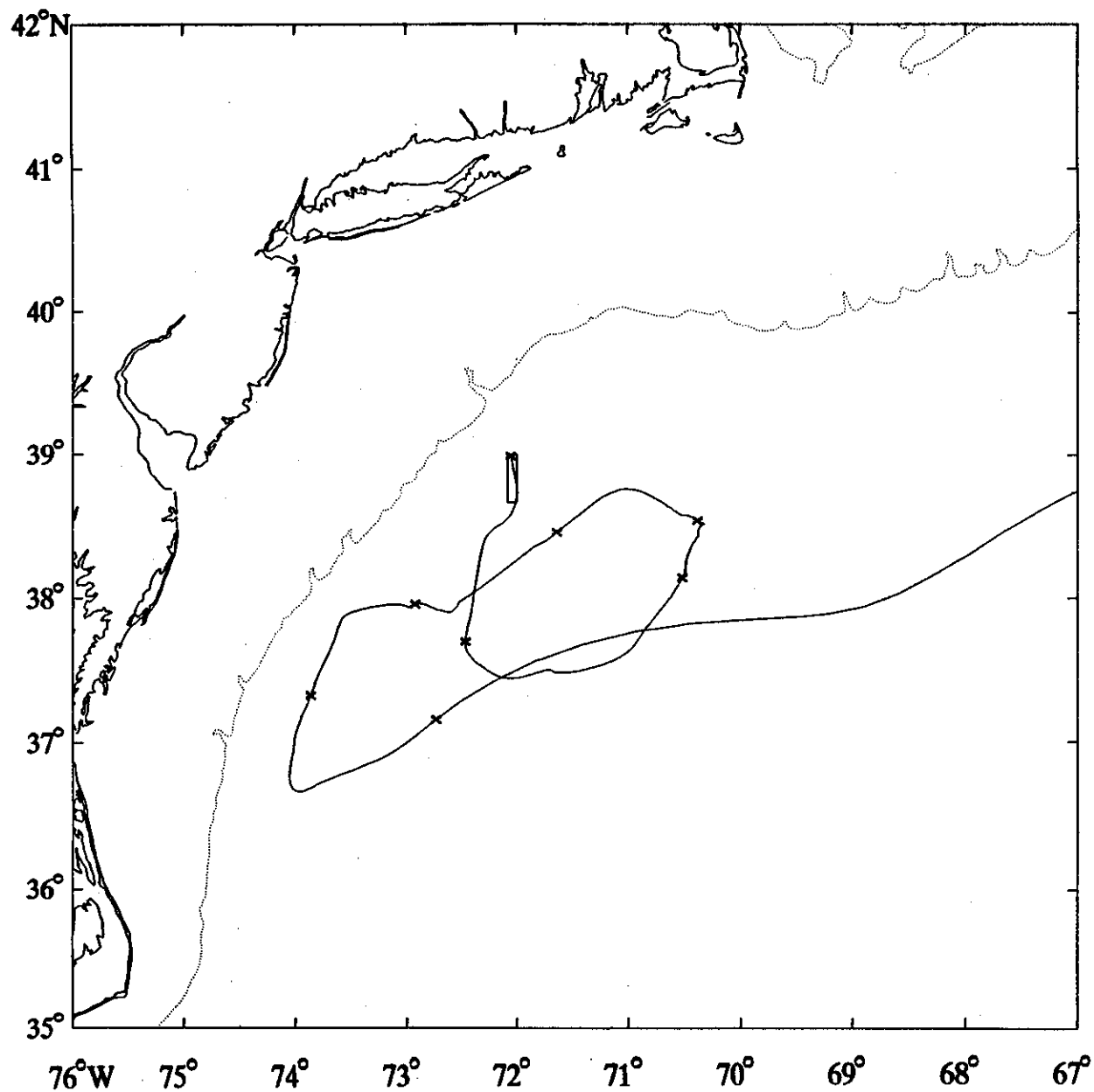


Figure A-2(b). Trajectory of drifter number 12746 deployed on September 19, 1990, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

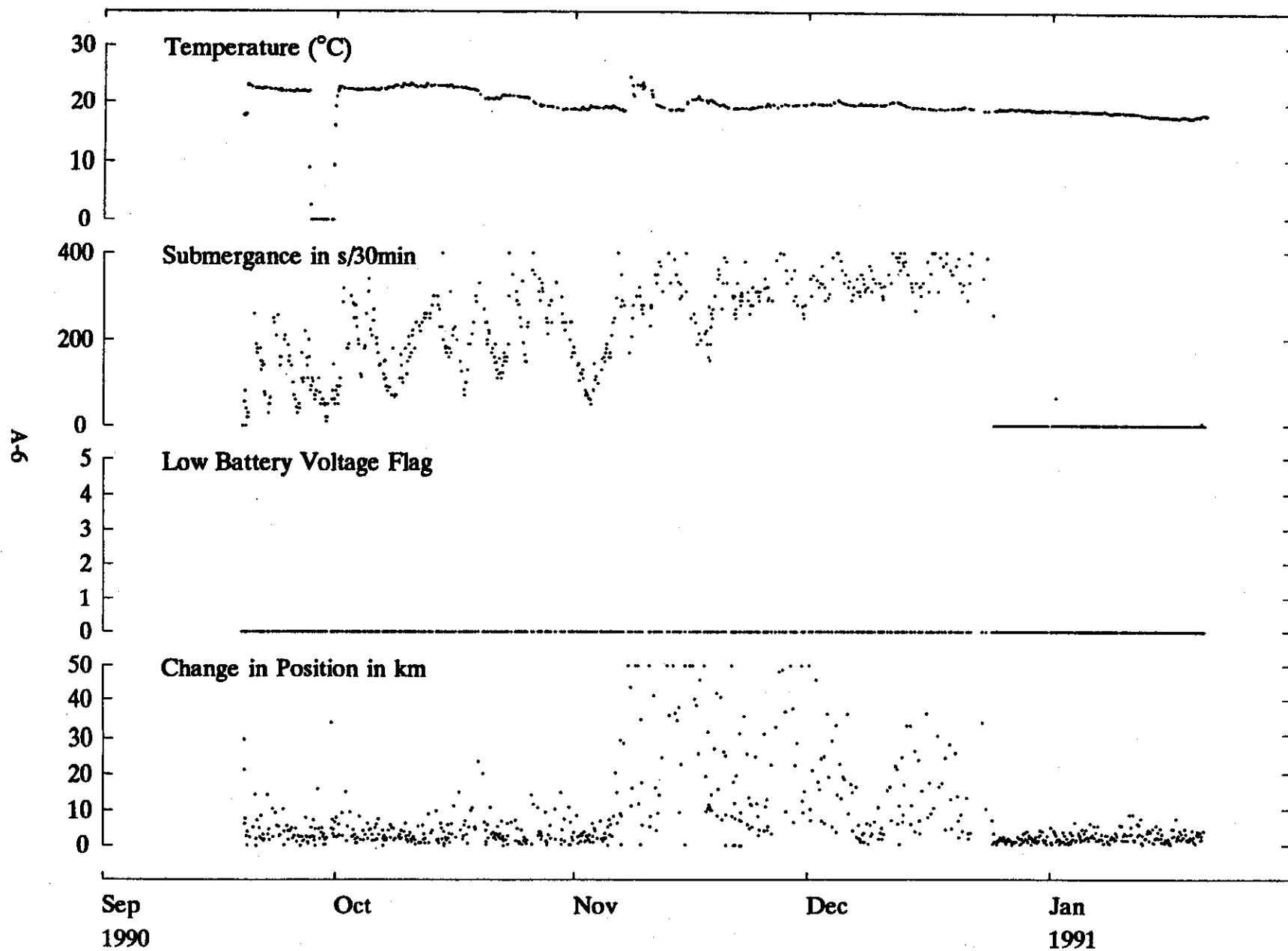
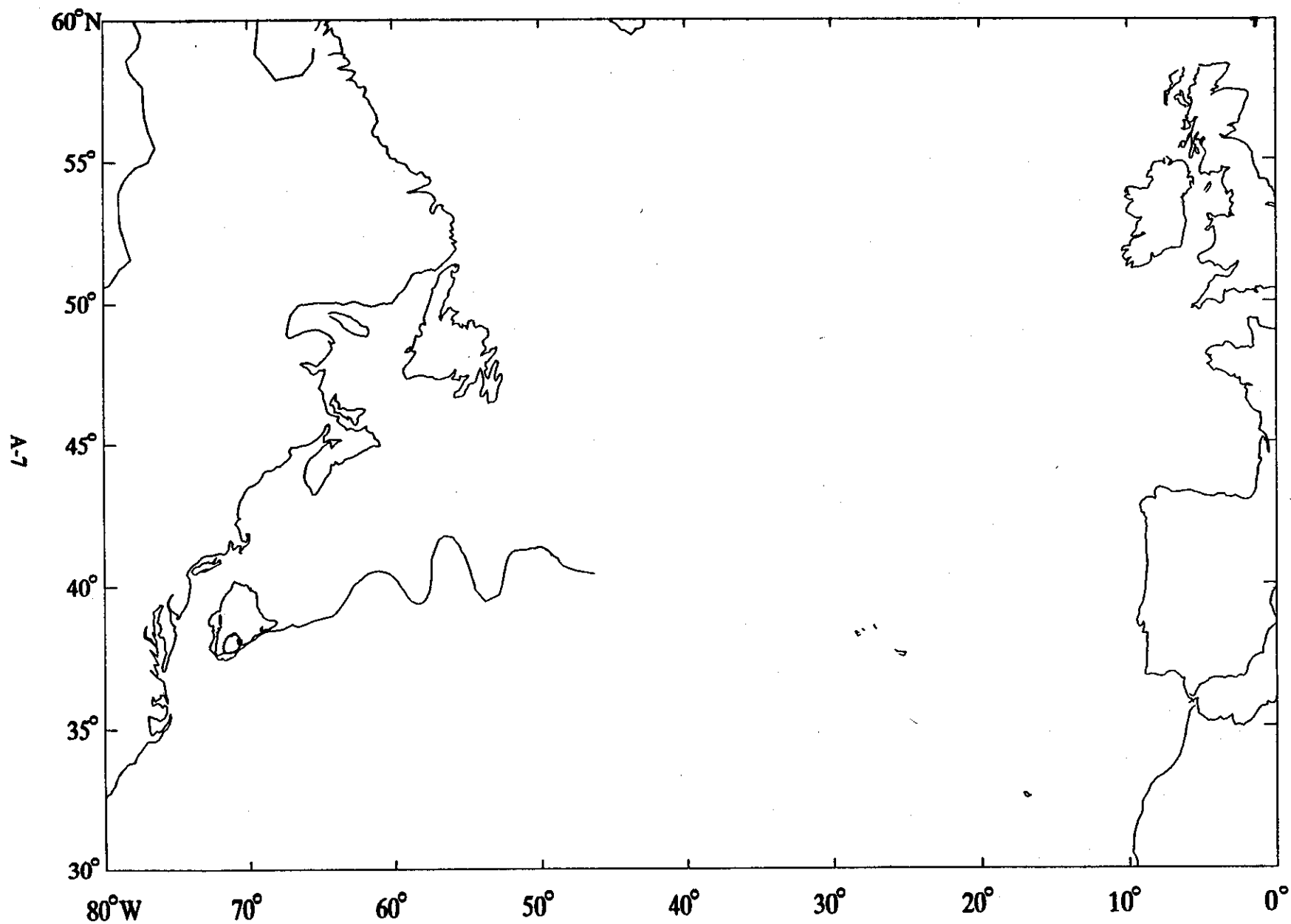


Figure A-2(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12746. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-3(a). Trajectory of drifter number 12750 deployed on September 13, 1990.
Last transmission received on January 14, 1991.**

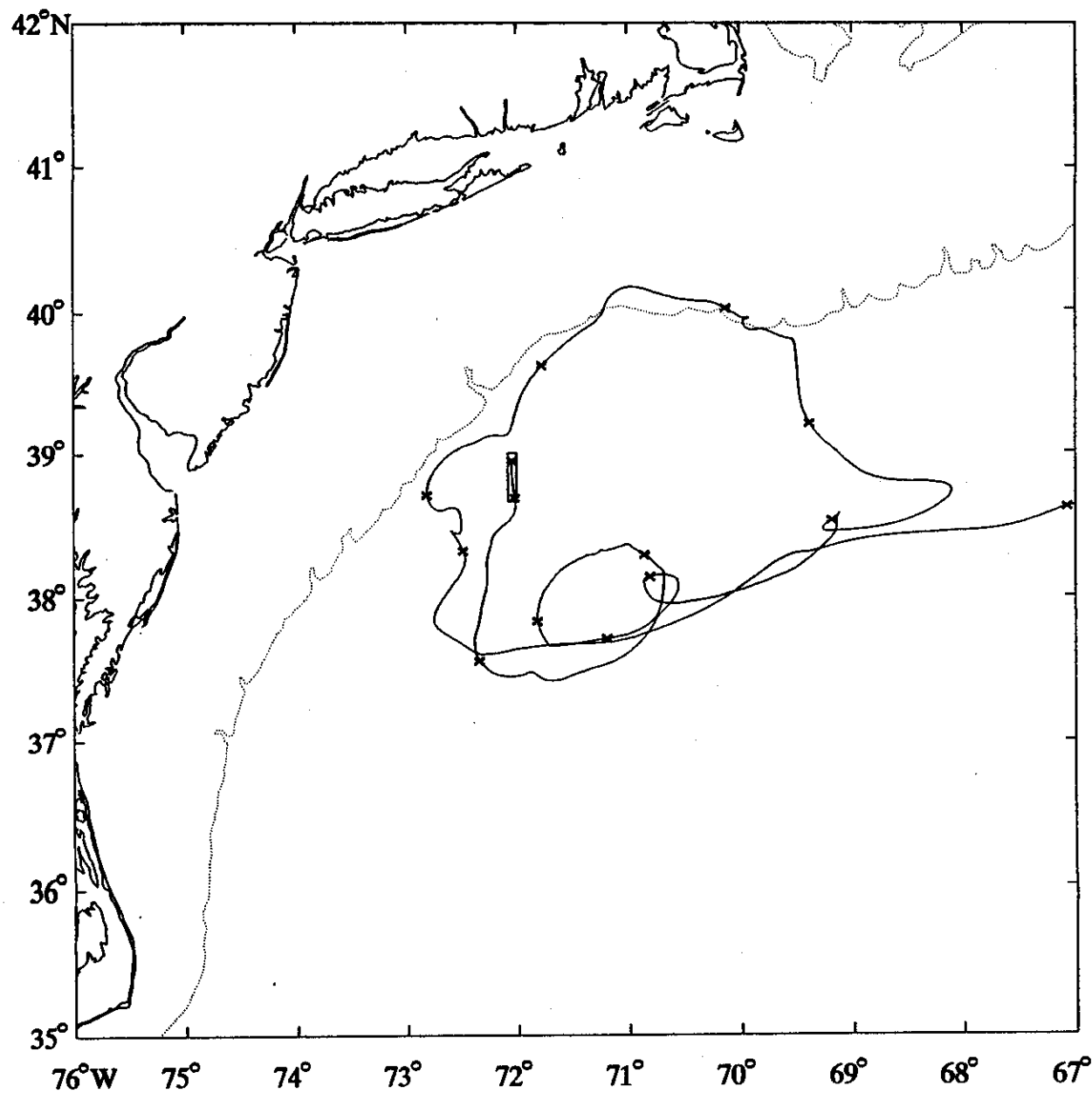


Figure A-3(b). Trajectory of drifter number 12750 deployed on September 13, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

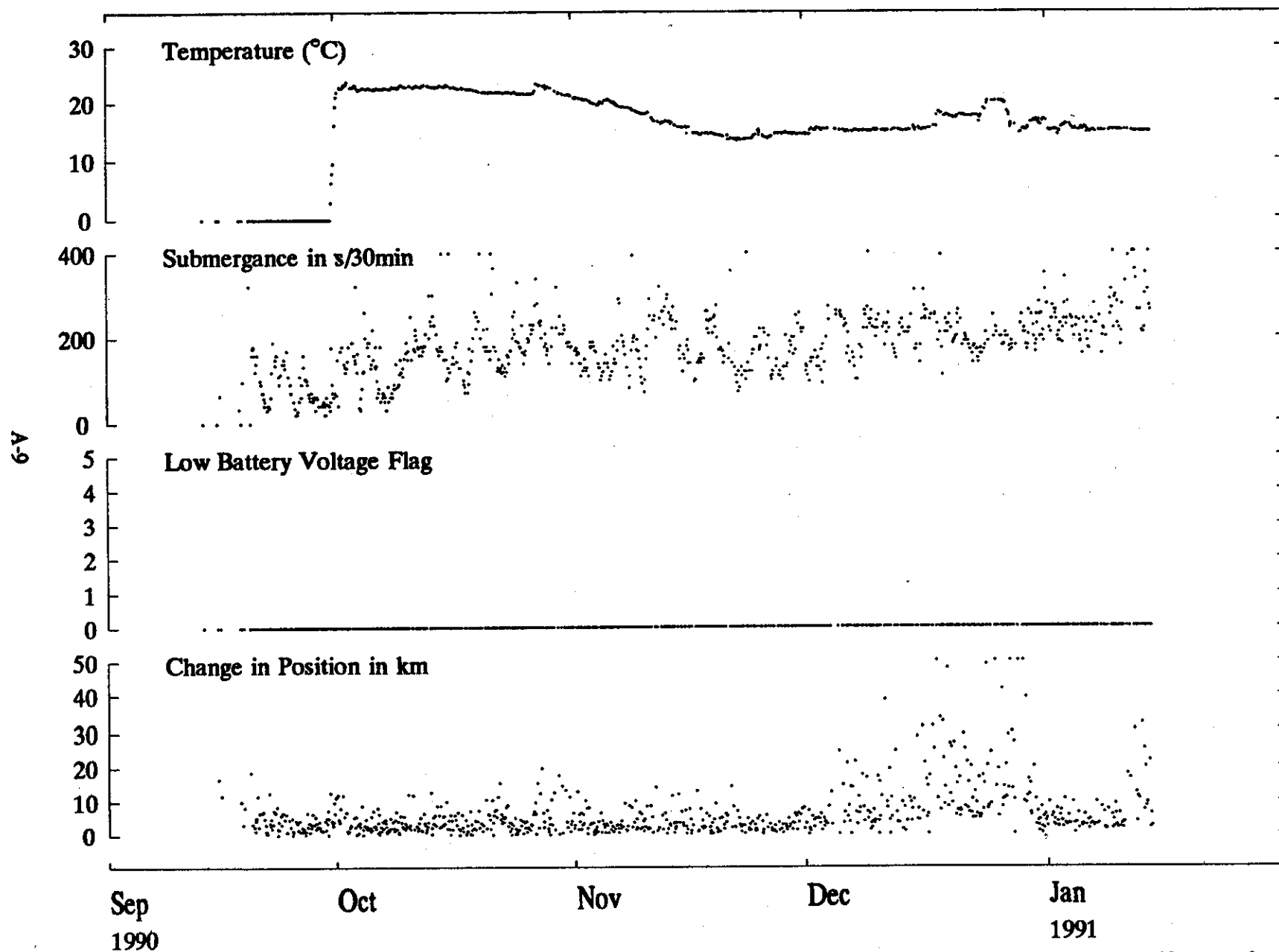


Figure A-3(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12750. The data have been quality-assured, removing transmission errors and wild points.

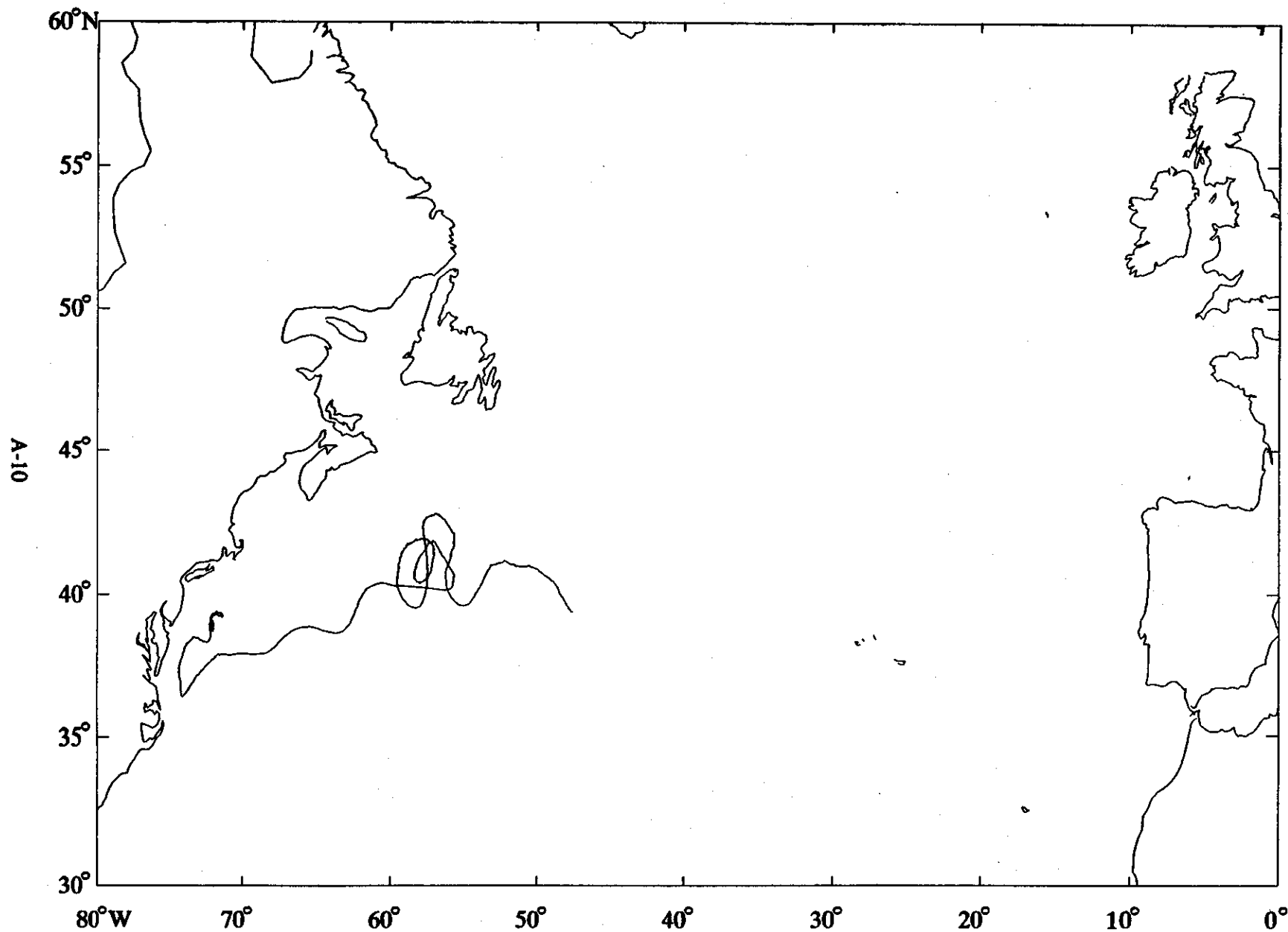


Figure A-4(a). Trajectory of drifter number 12752 deployed on October 4, 1990.
Last transmission received on January 30, 1991.

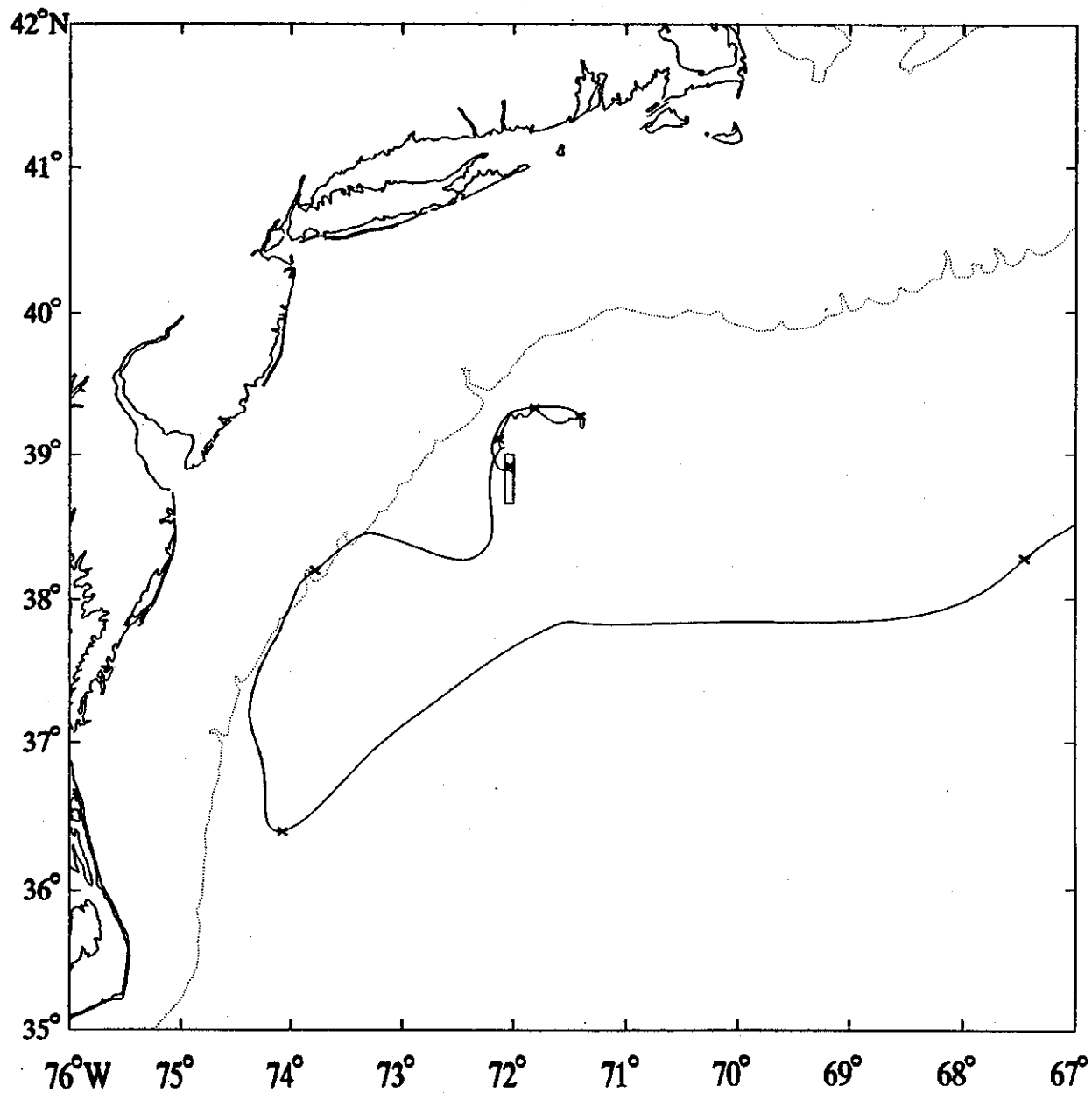


Figure A-4(b). Trajectory of drifter number 12752 deployed on October 4, 1990, shown in the vicinity of the Mid-Atlantic Bight.
 The 106-Mile Site is indicated by the rectangle near the center of the figure.
 Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

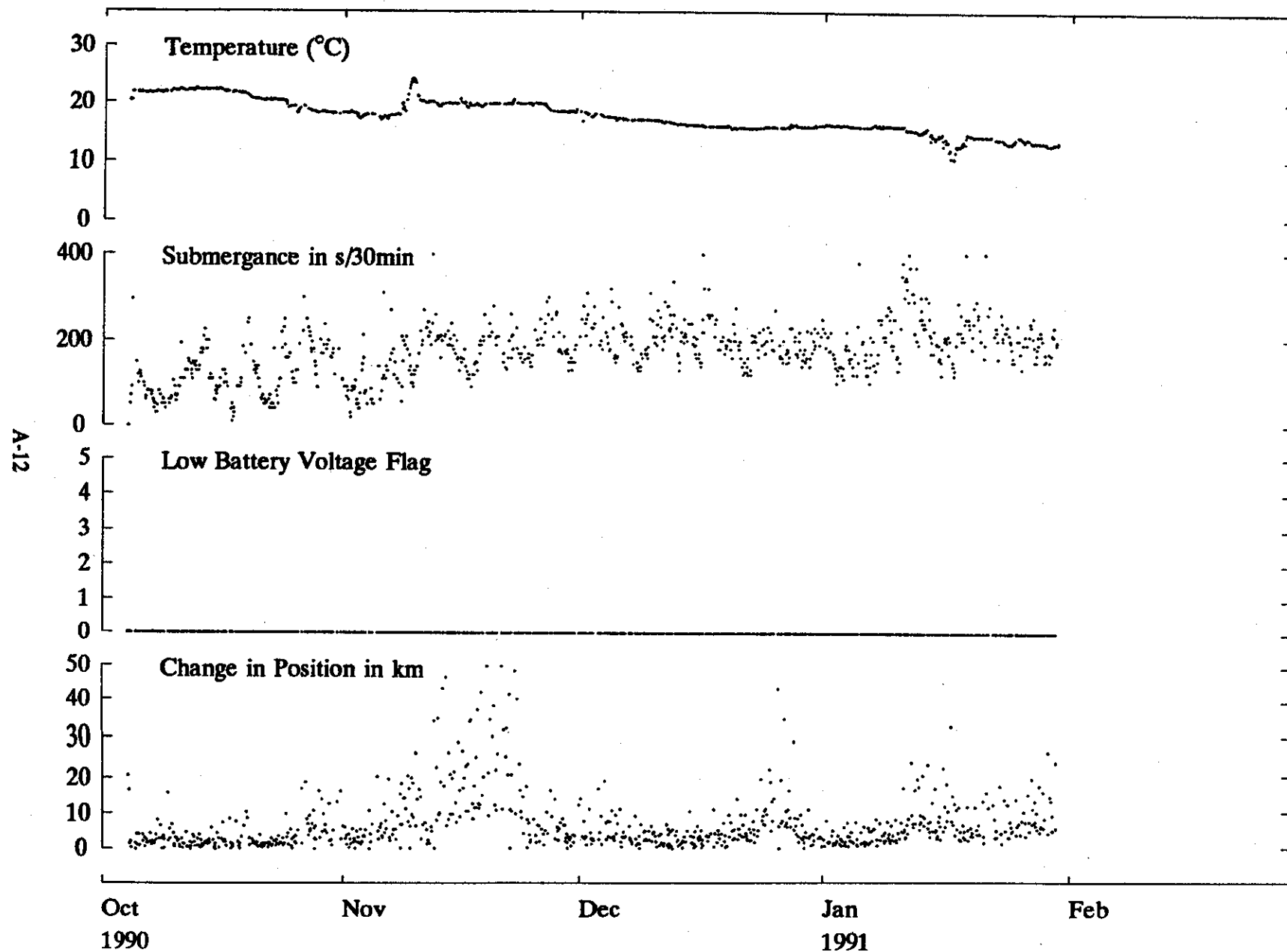
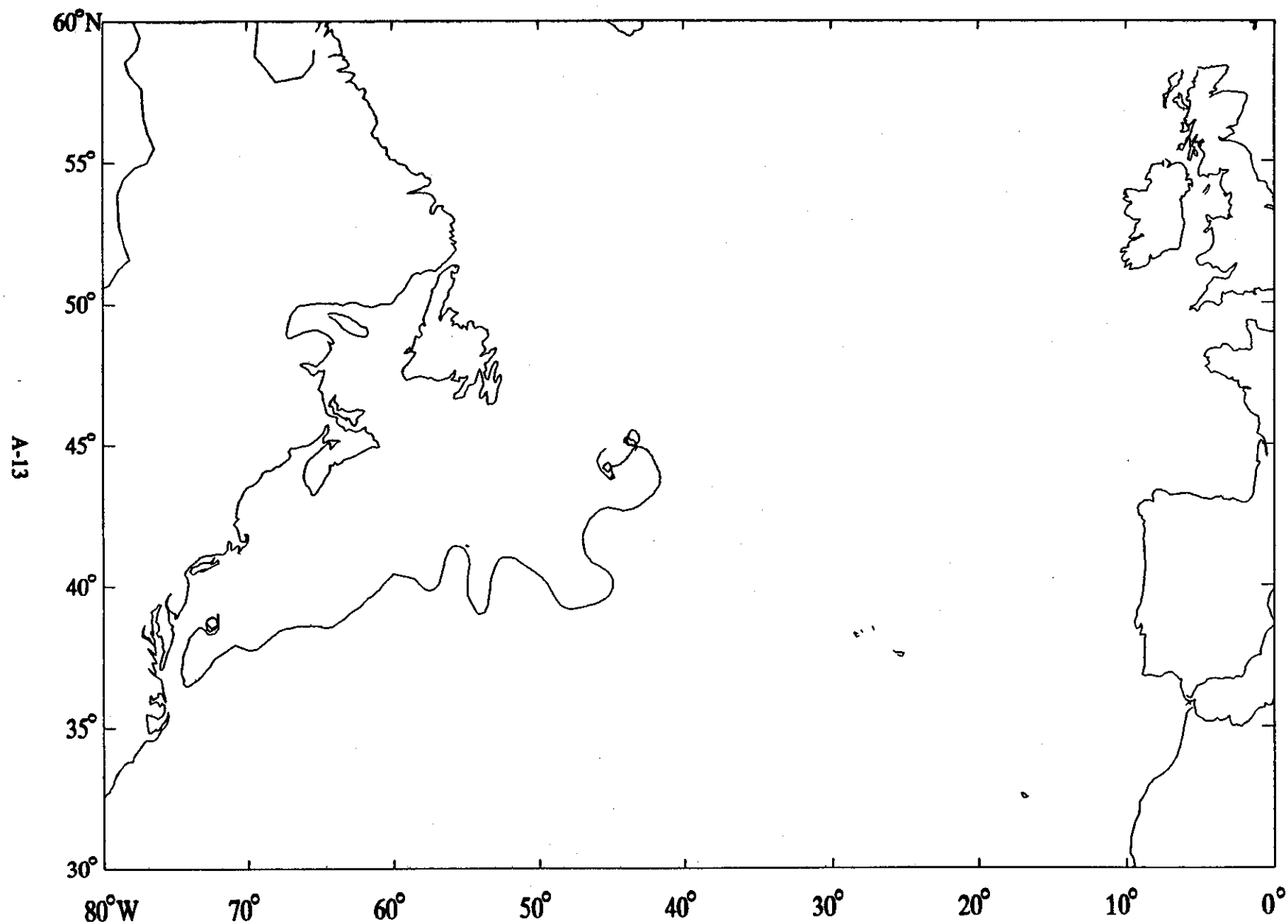


Figure A-4(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12752. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-5(a). Trajectory of drifter number 12753 deployed on October 15, 1990.
Last transmission received on February 13, 1991.**

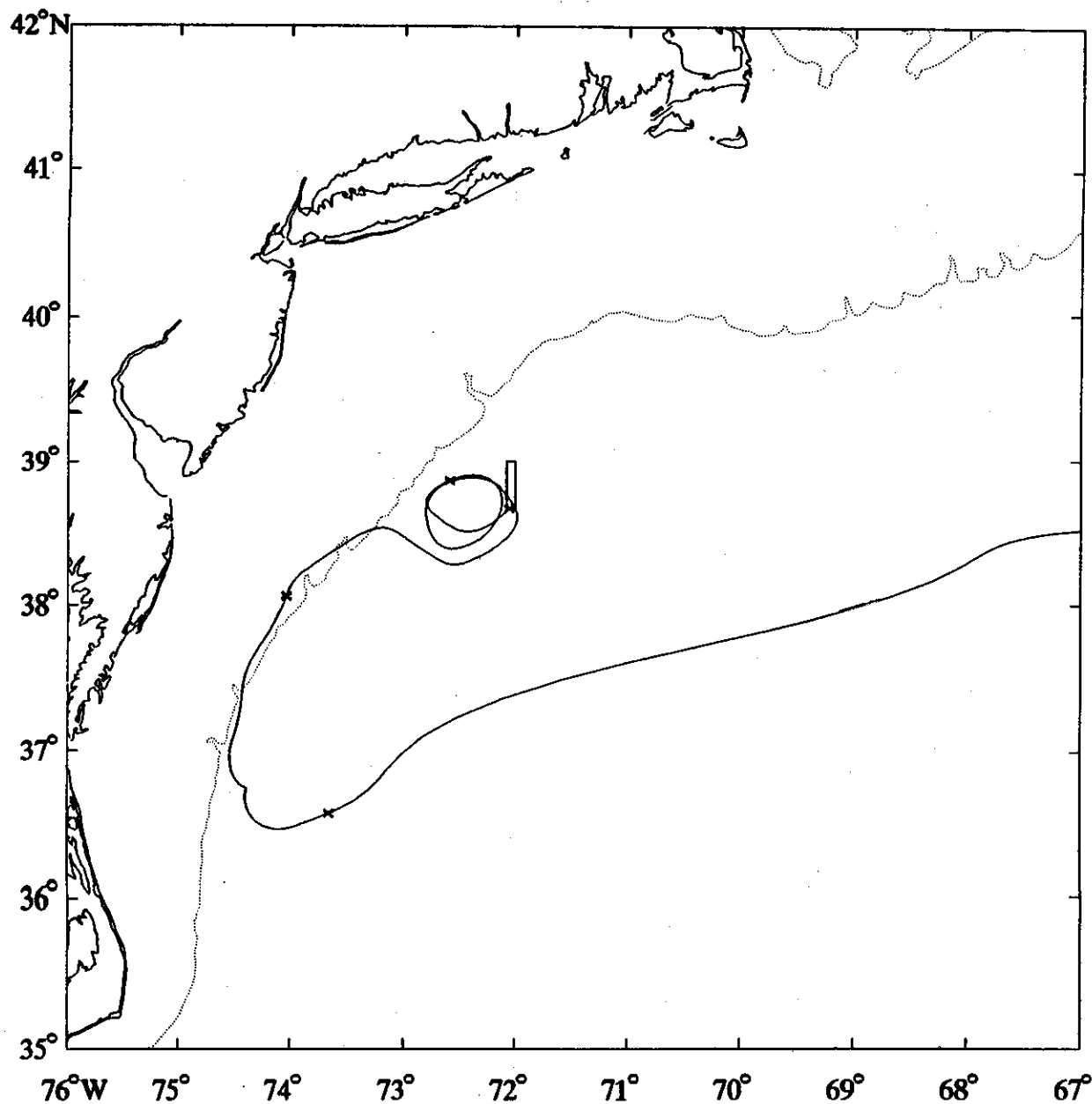


Figure A-5(b). Trajectory of drifter number 12753 deployed on October 15, 1990, shown in the vicinity of the Mid-Atlantic Bight.
 The 106-Mile Site is indicated by the rectangle near the center of the figure.
 Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

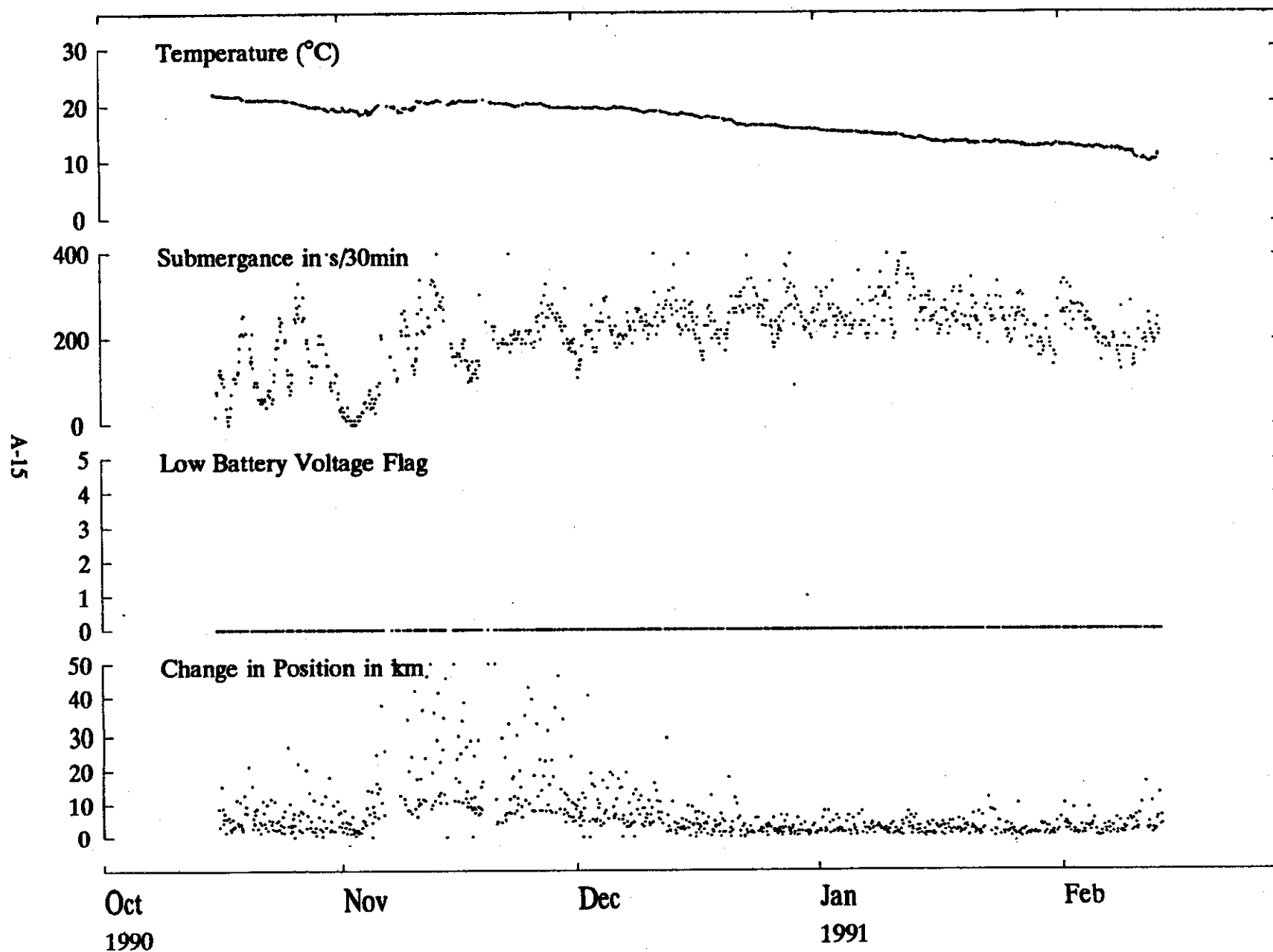
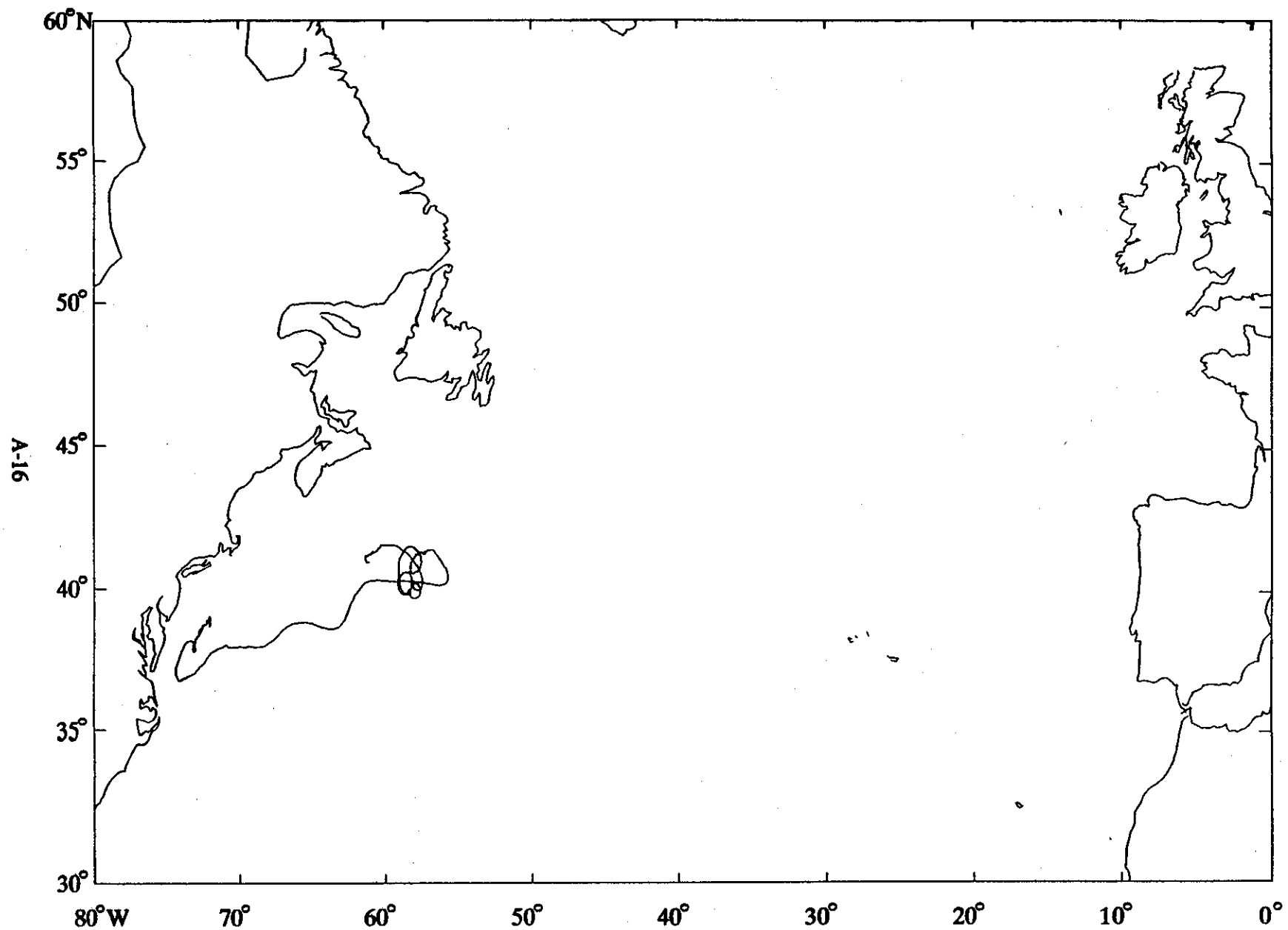


Figure A-5(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12753. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-6(a). Trajectory of drifter number 12754 deployed on September 23, 1990.
Last transmission received on January 20, 1991.**

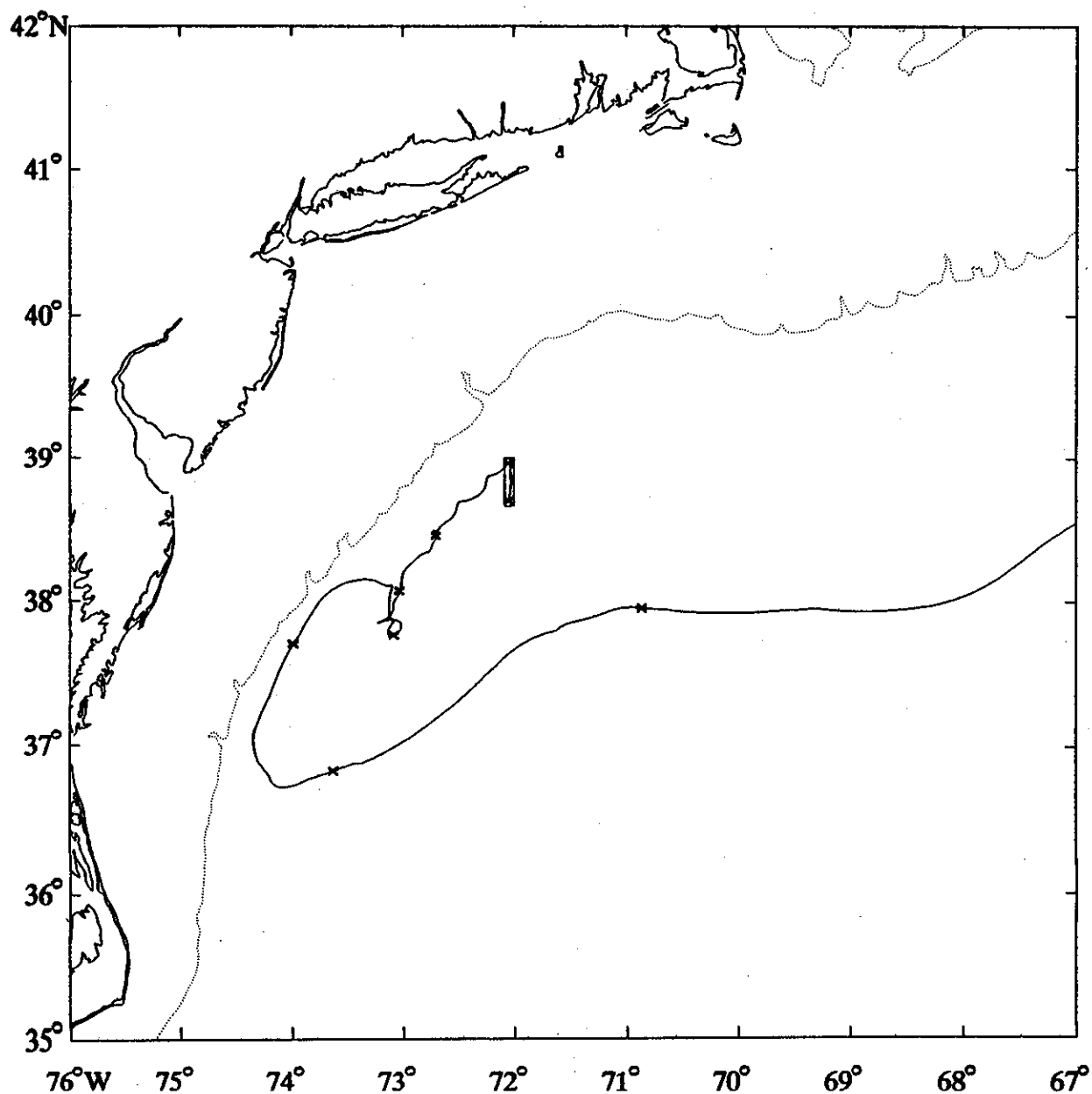


Figure A-6(b). Trajectory of drifter number 12754 deployed on September 23, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

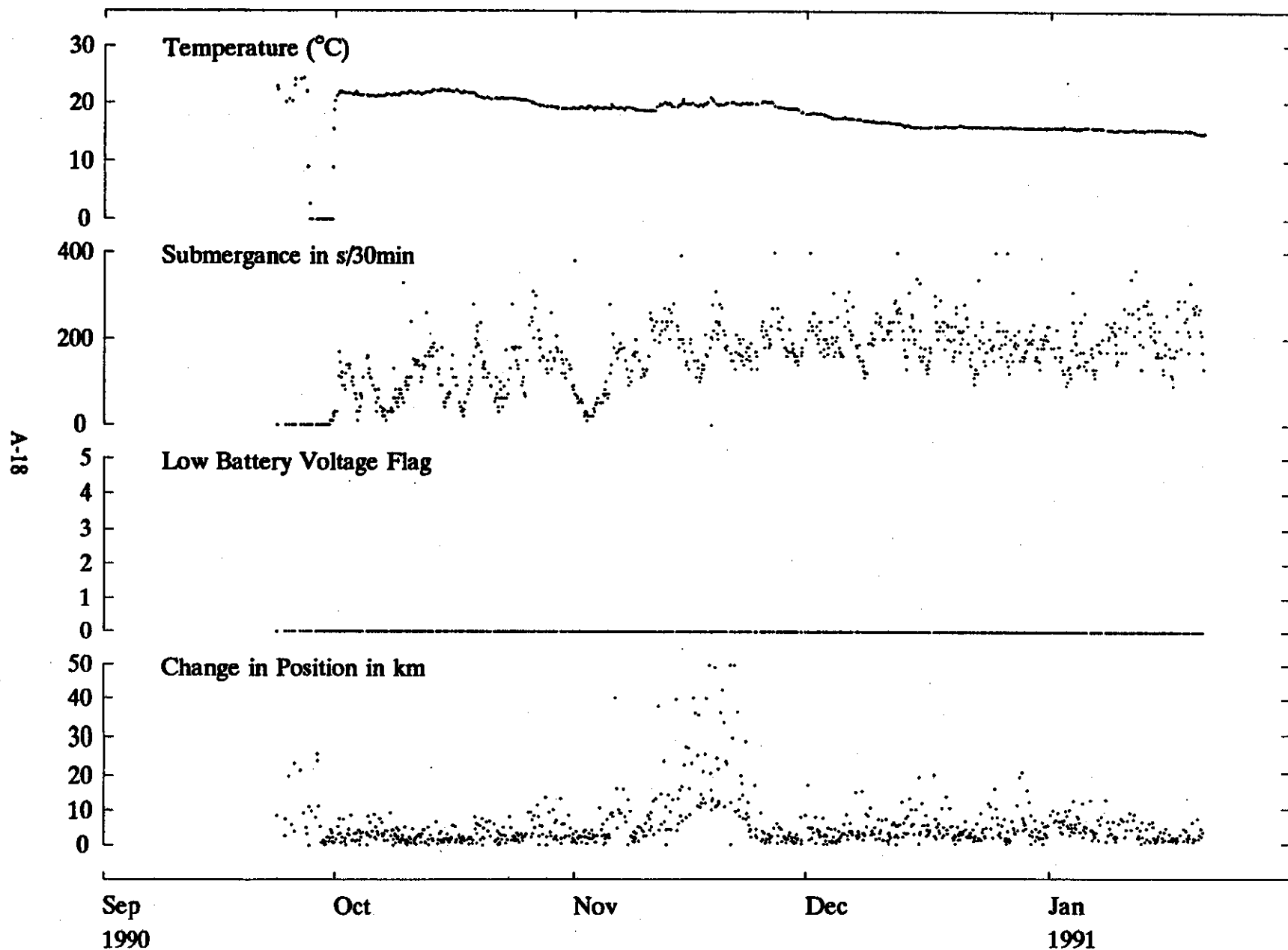
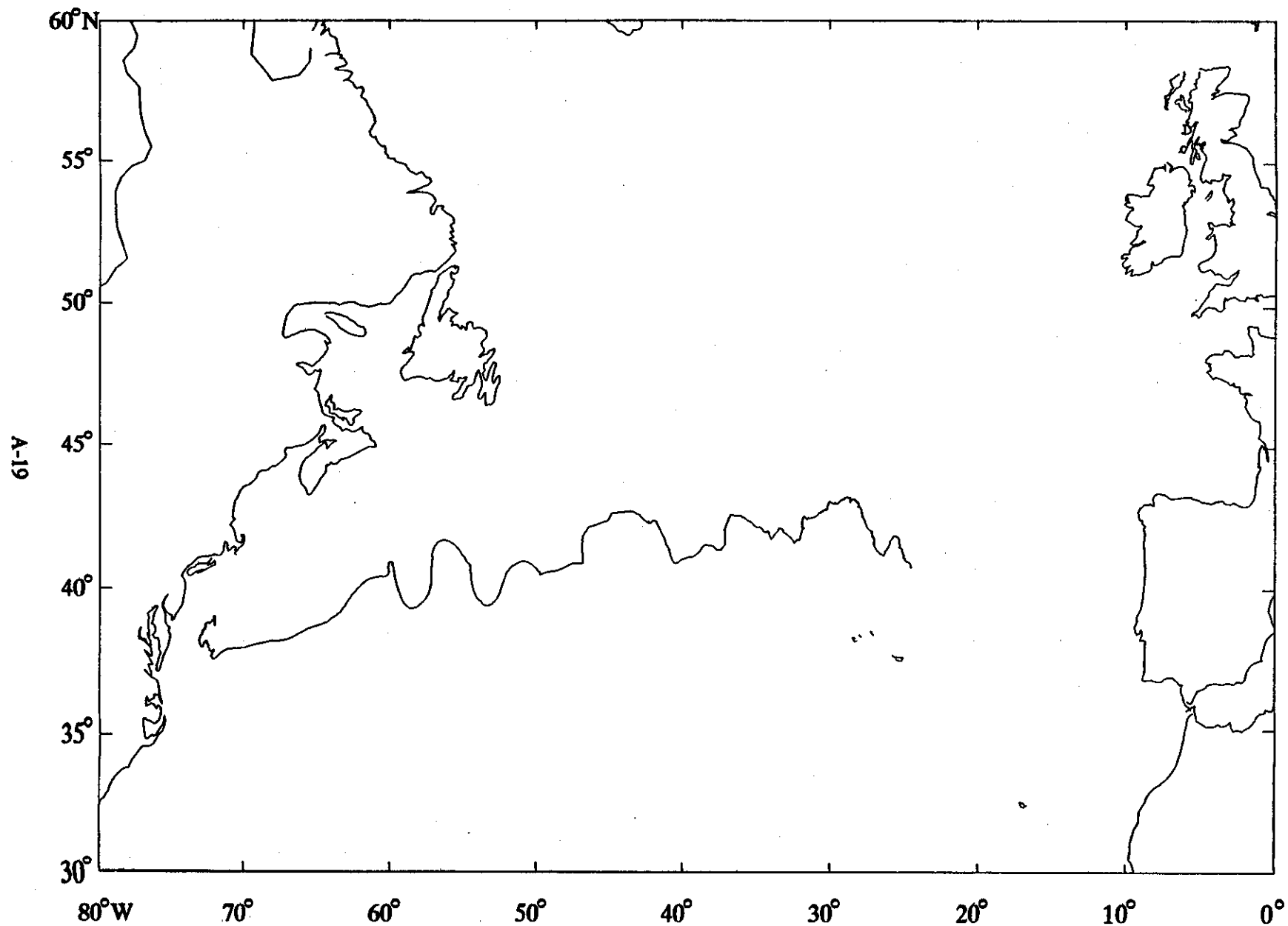


Figure A-6(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12754. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-7(a). Trajectory of drifter number 12757 deployed on November 21, 1990.
Last transmission received on March 21, 1991.**

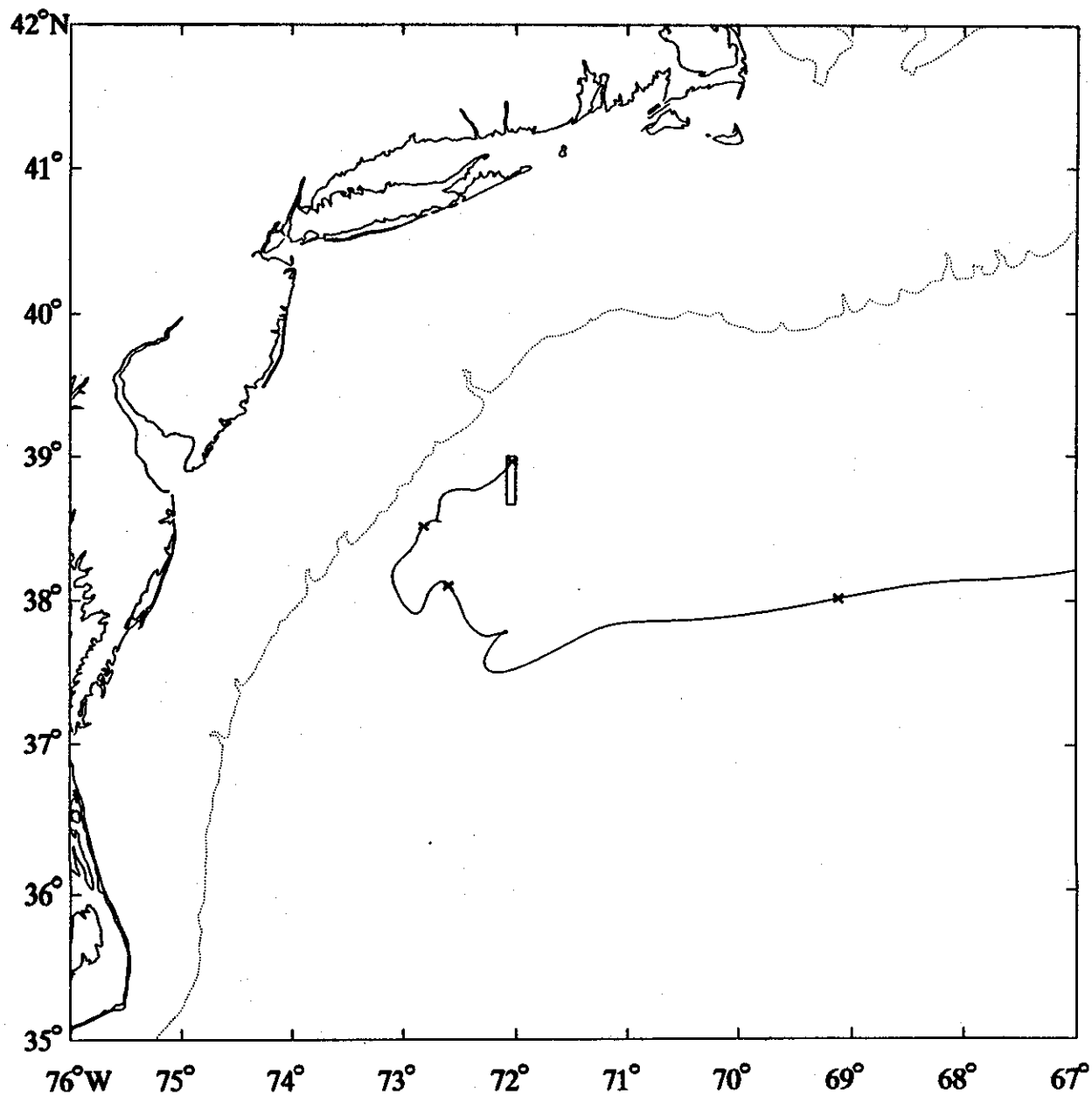


Figure A-7(b). Trajectory of drifter number 12757 deployed on November 21, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

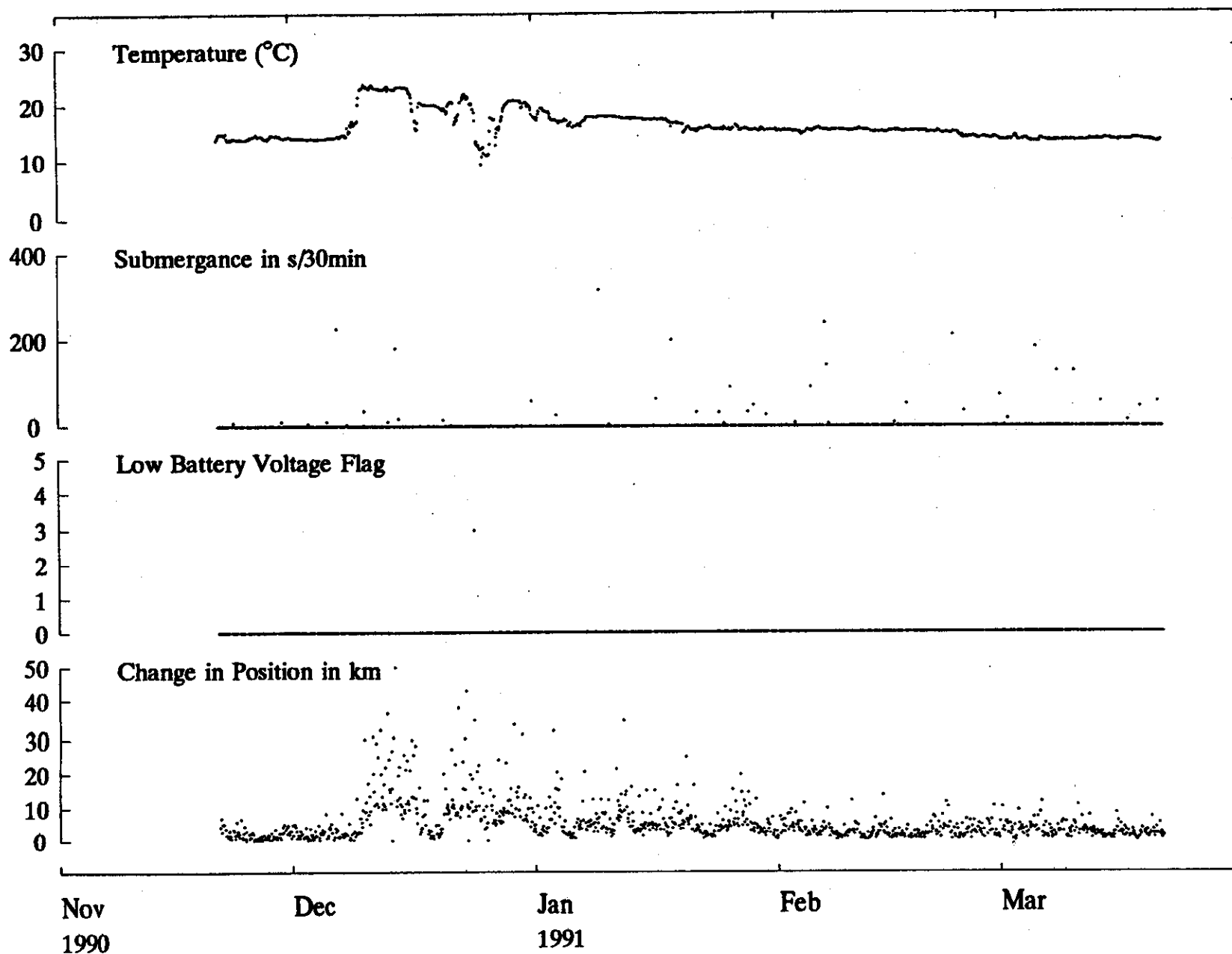
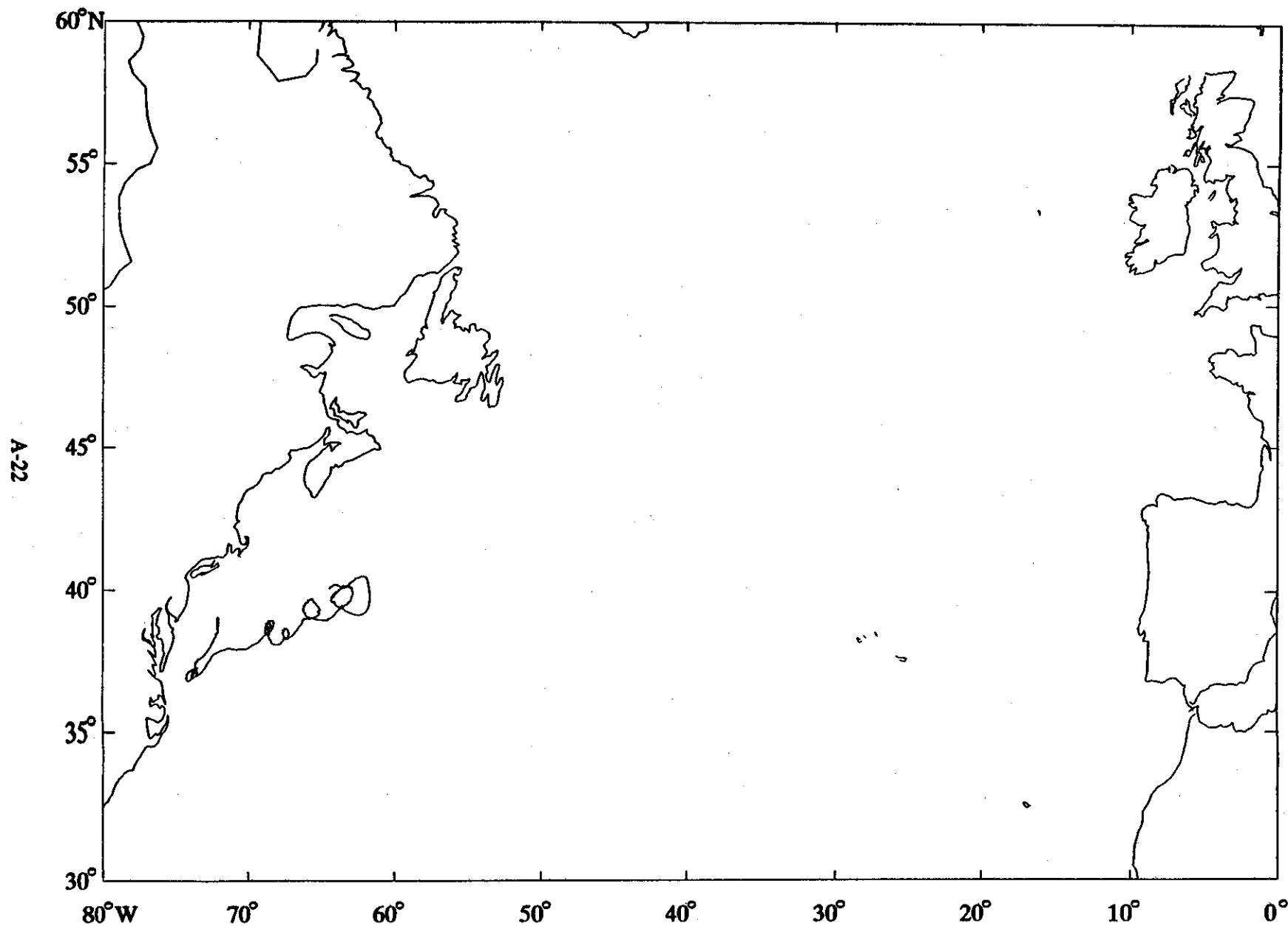


Figure A-7(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12757. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-8(a). Trajectory of drifter number 12758 deployed on November 15, 1990.
Last transmission received on March 17, 1991.**

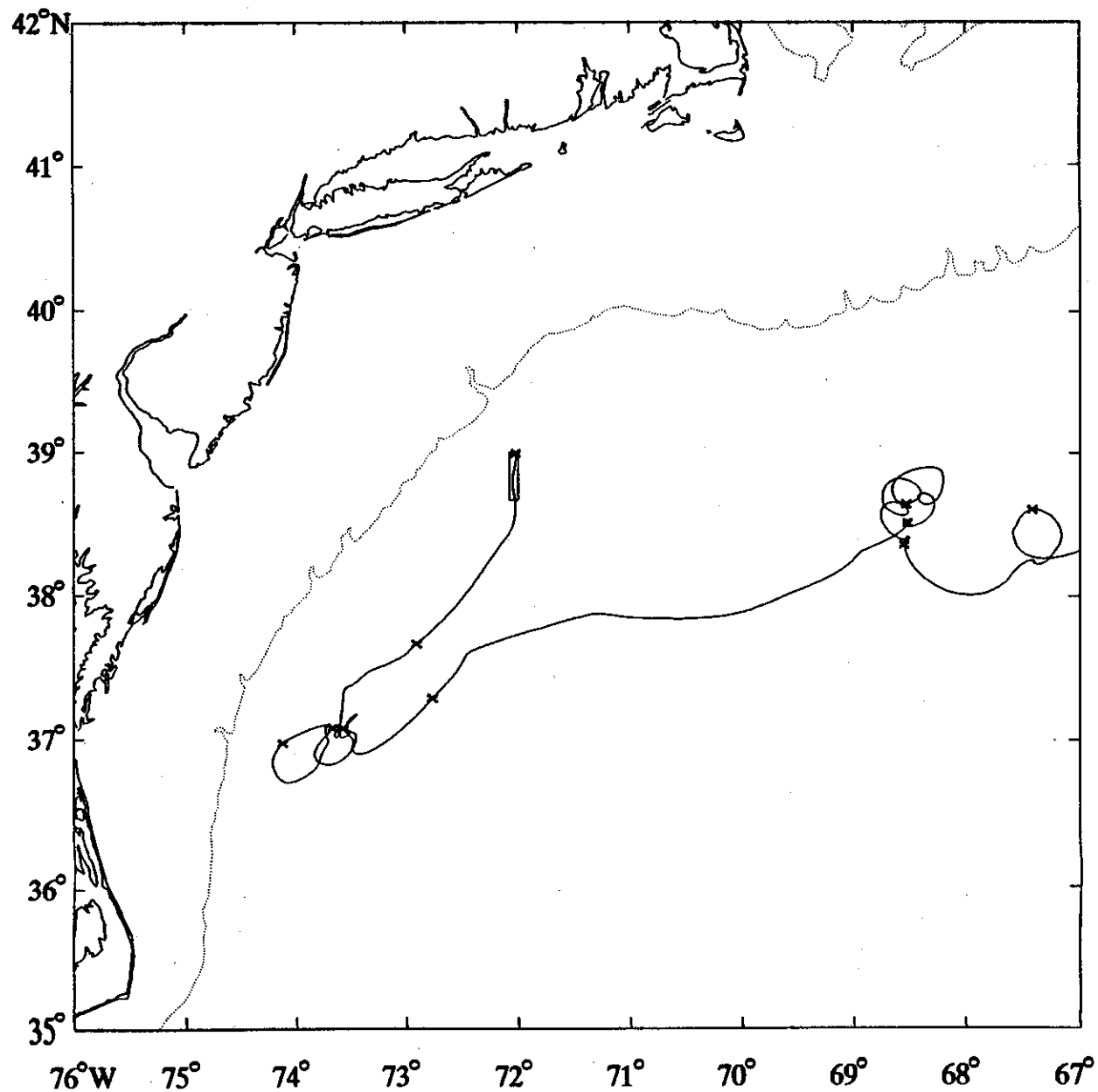


Figure A-8(b). Trajectory of drifter number 12758 deployed on November 15, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

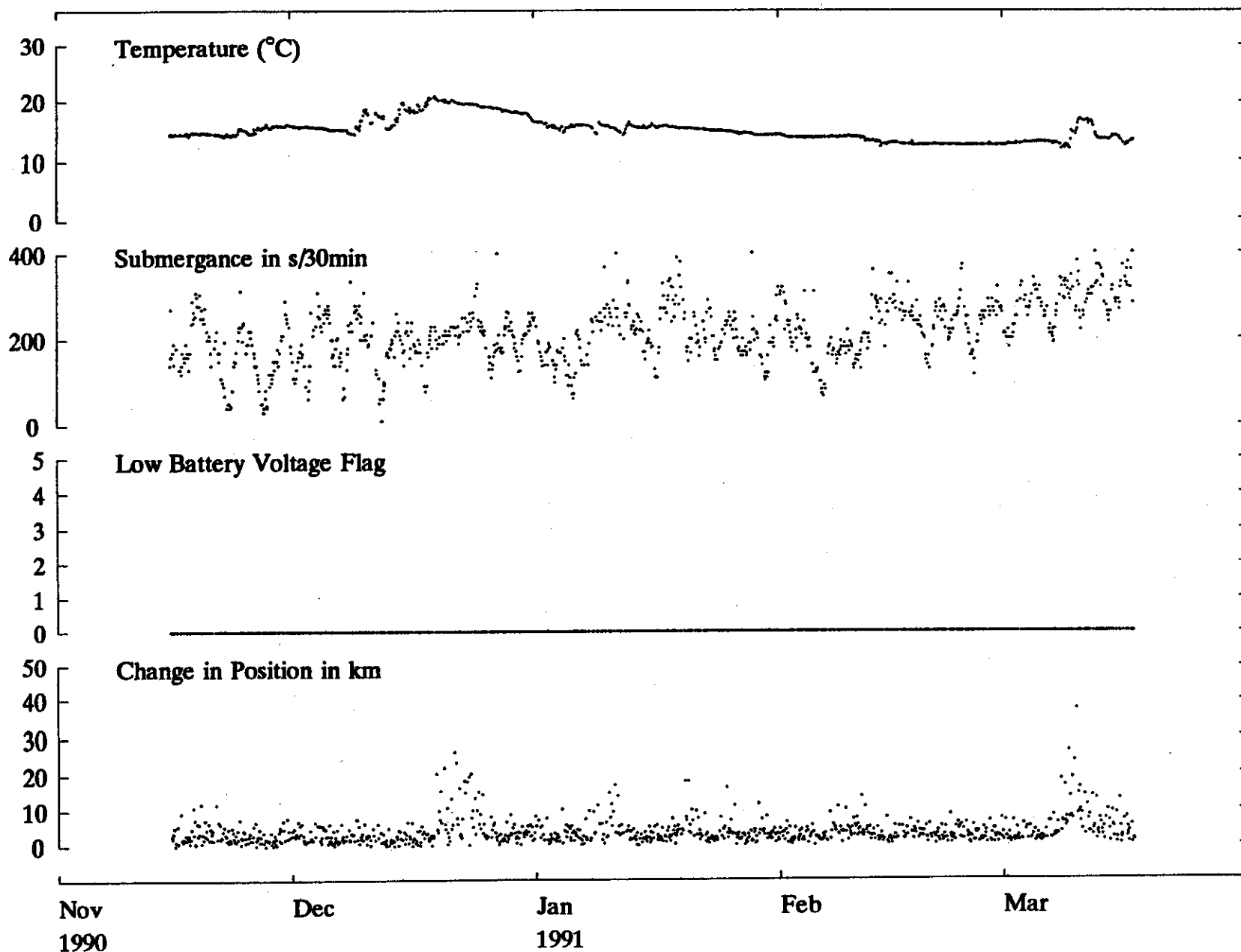
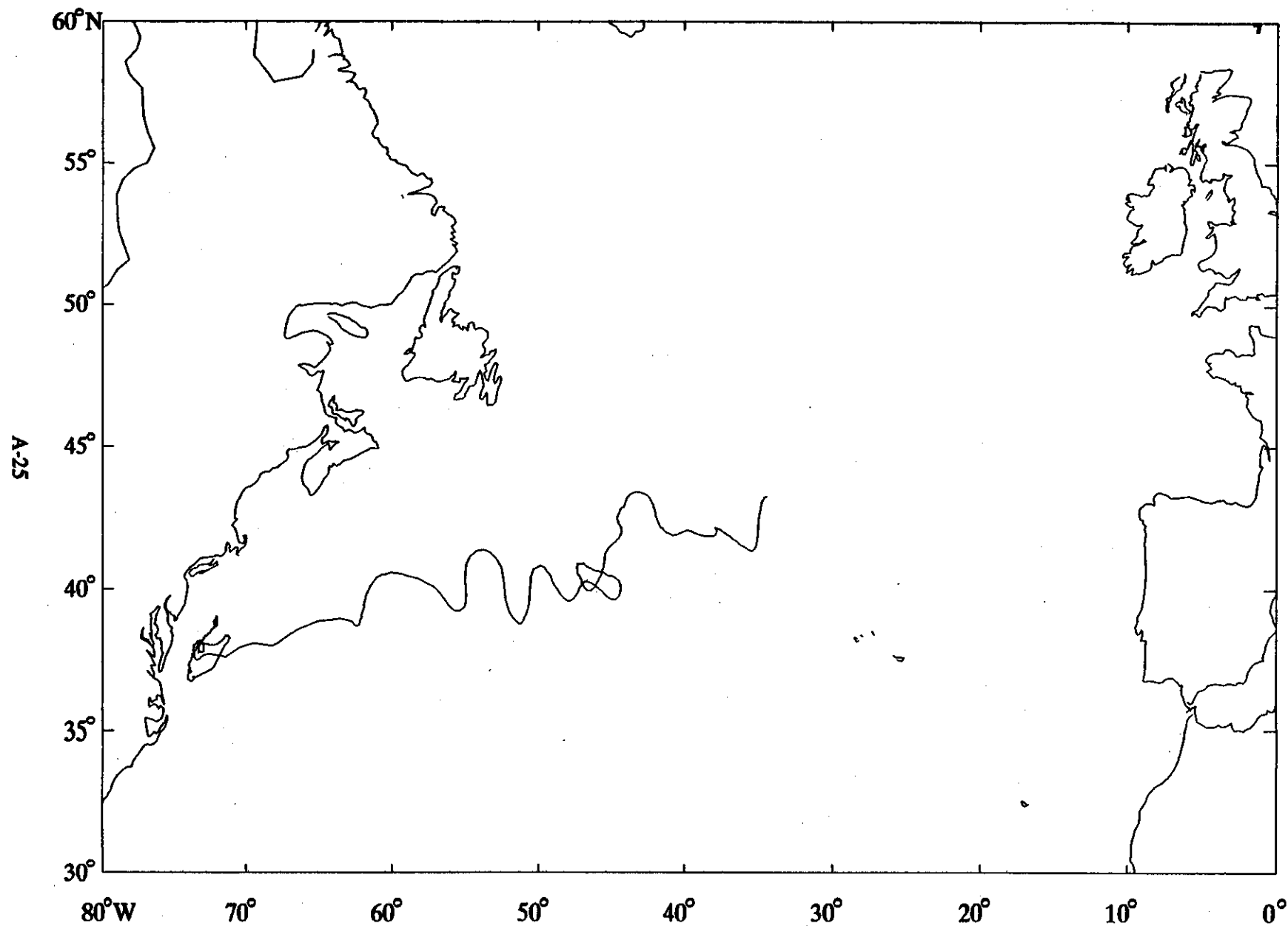


Figure A-8(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12758. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-9(a). Trajectory of drifter number 12759 deployed on November 28, 1990.
Last transmission received on March 31, 1991.**

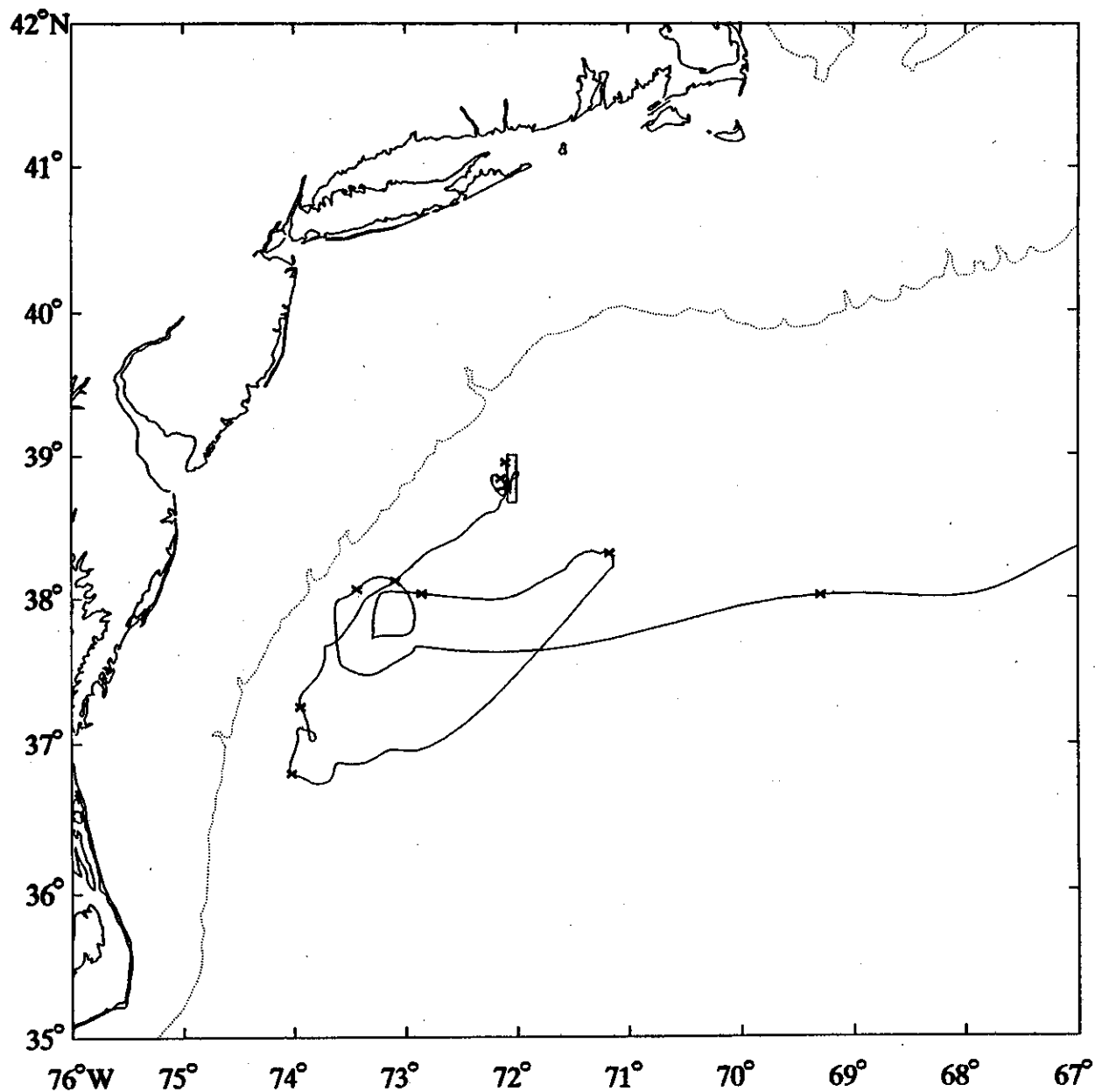


Figure A-9(b). Trajectory of drifter number 12759 deployed on November 28, 1990, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

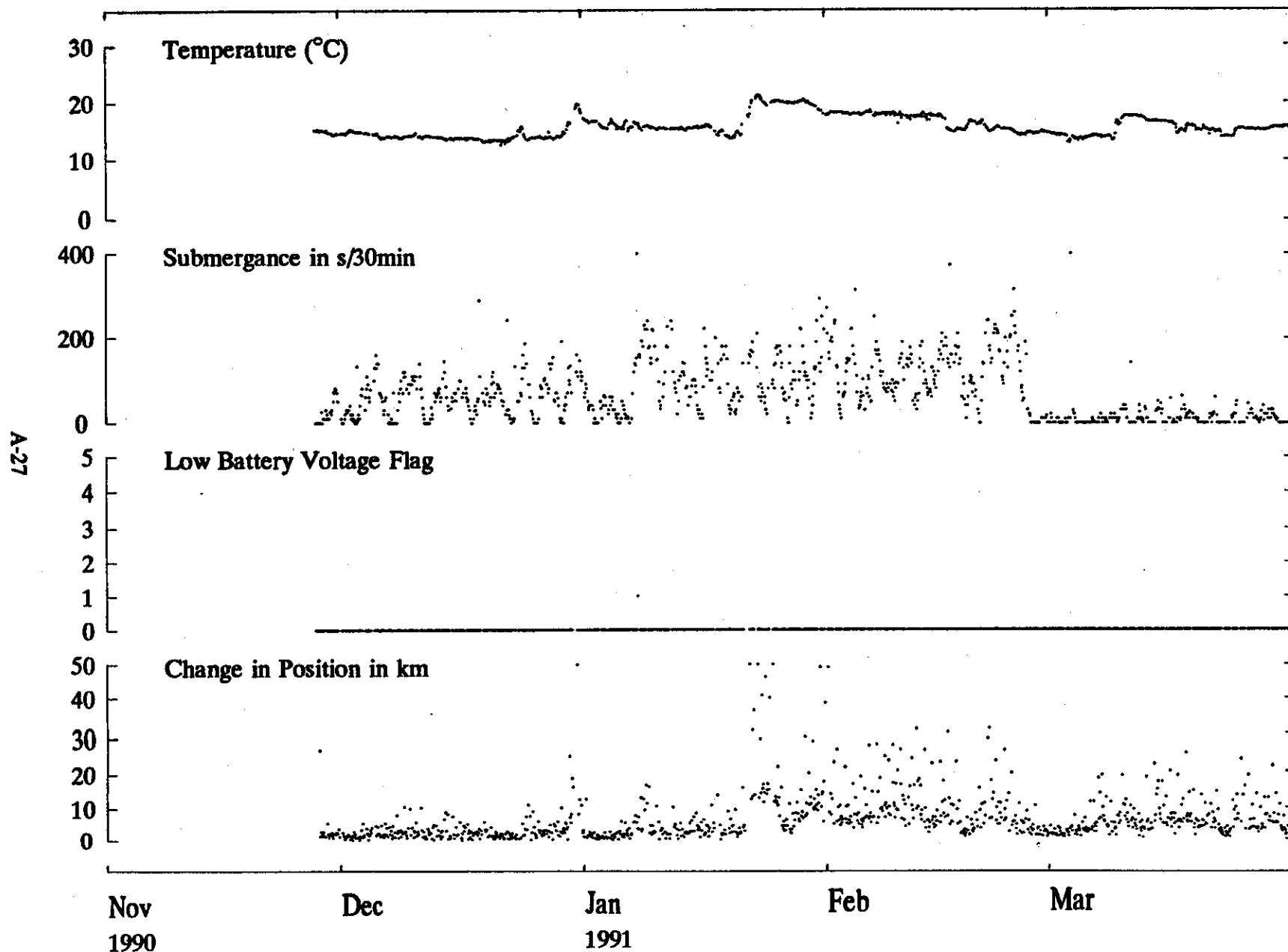
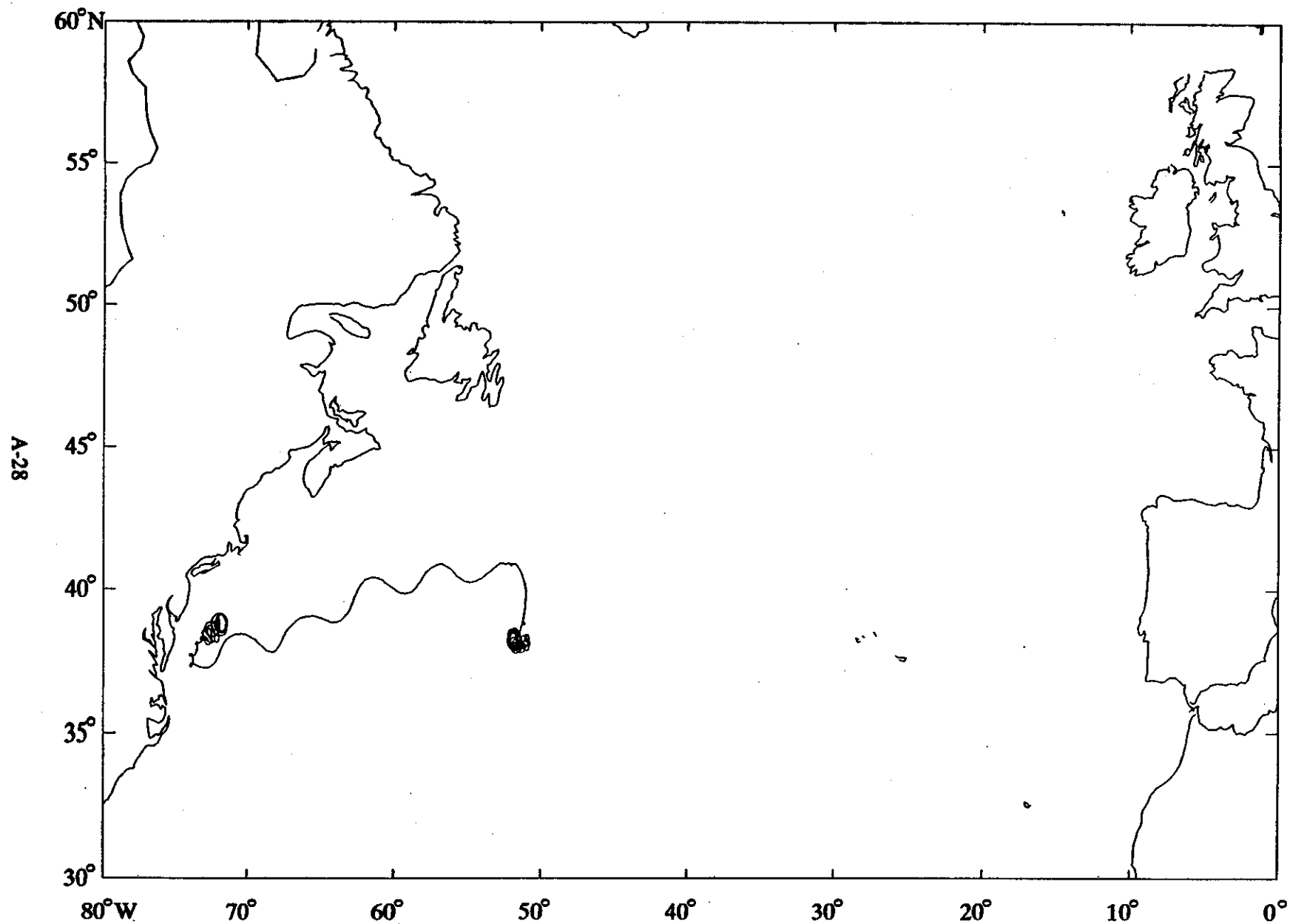


Figure A-9(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12759. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-10(a). Trajectory of drifter number 12760 deployed on December 15, 1990.
Last transmission received on April 18, 1991.**

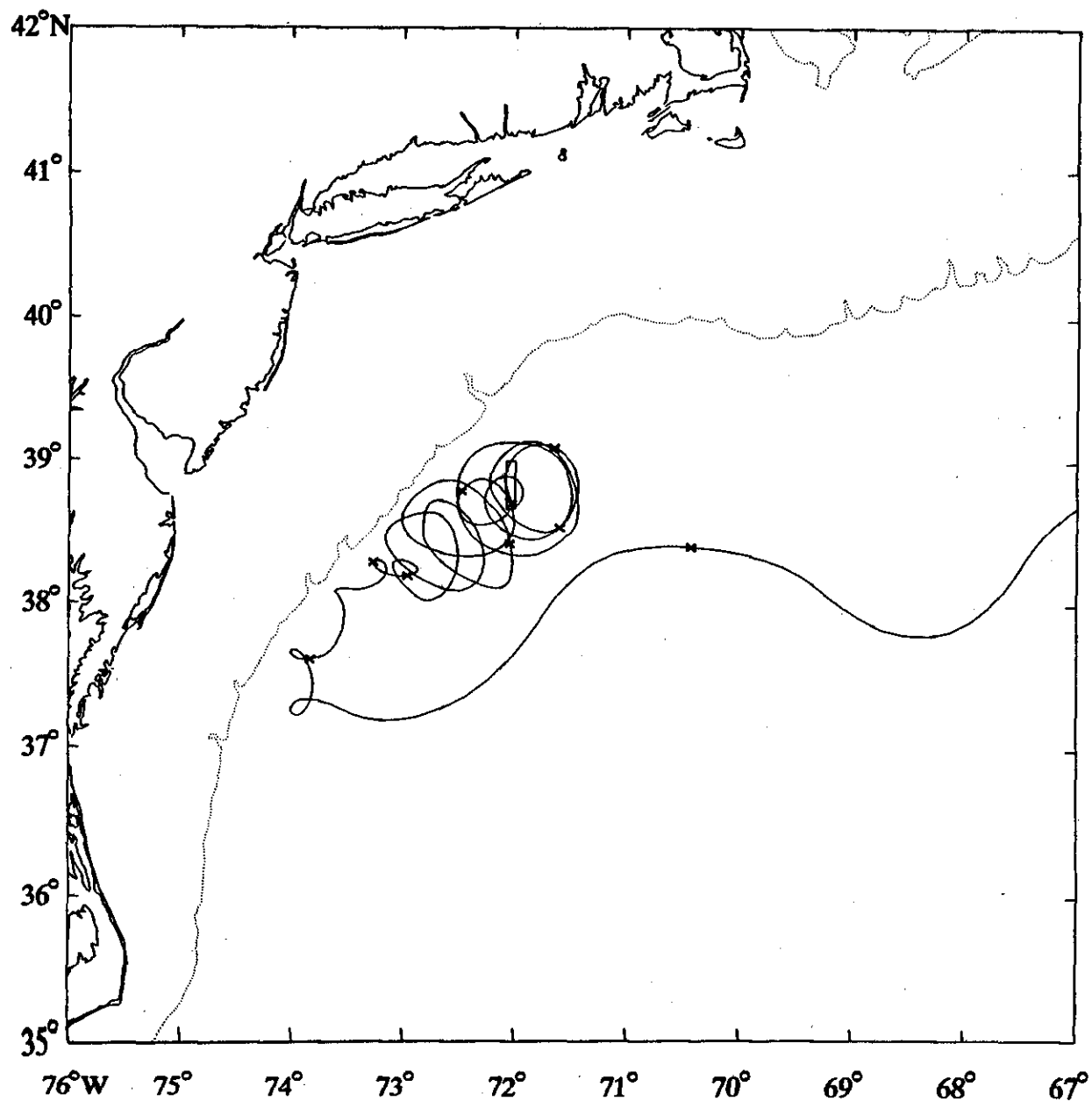


Figure A-10(b). Trajectory of drifter number 12760 deployed on December 15, 1990, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

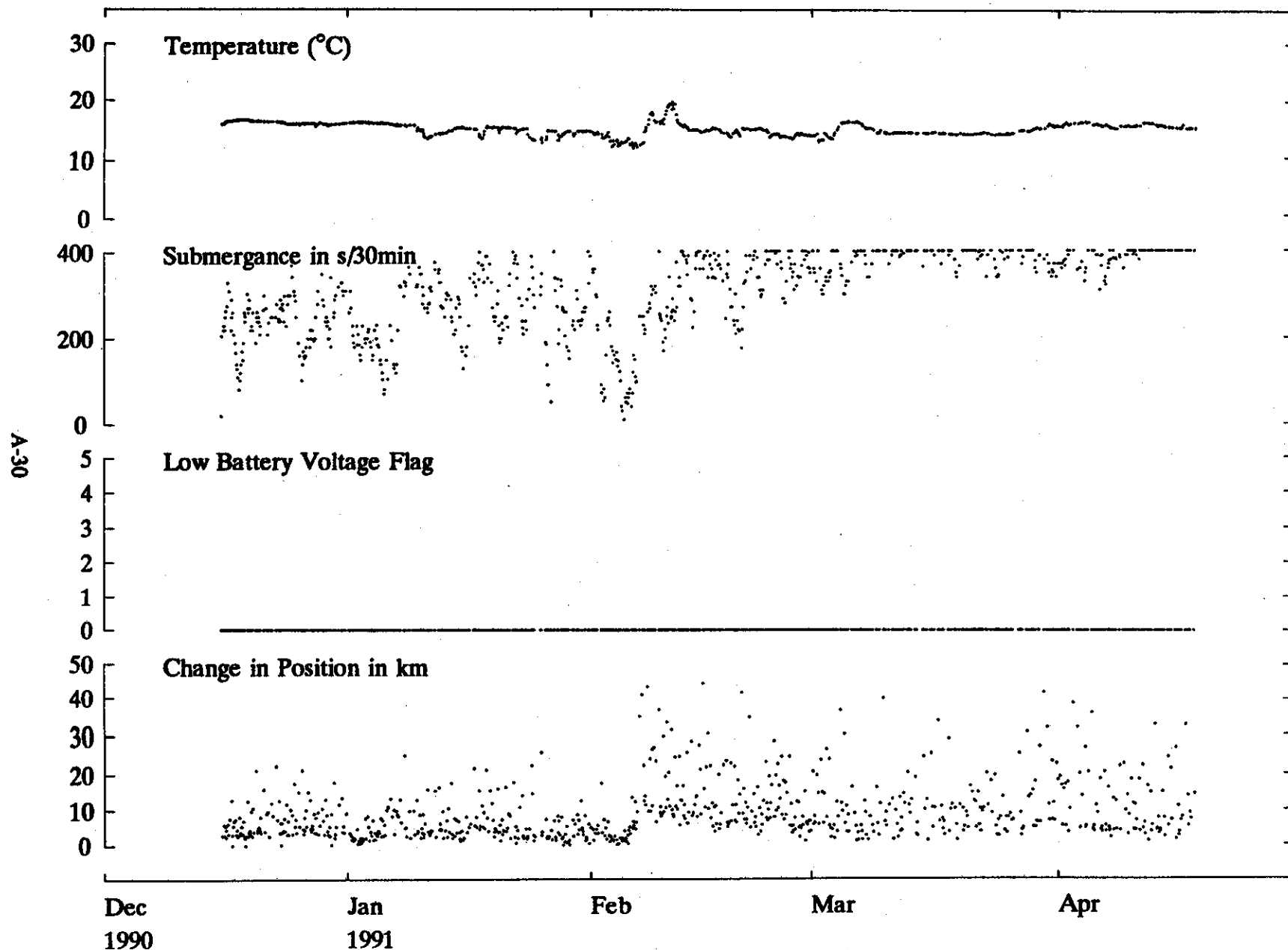
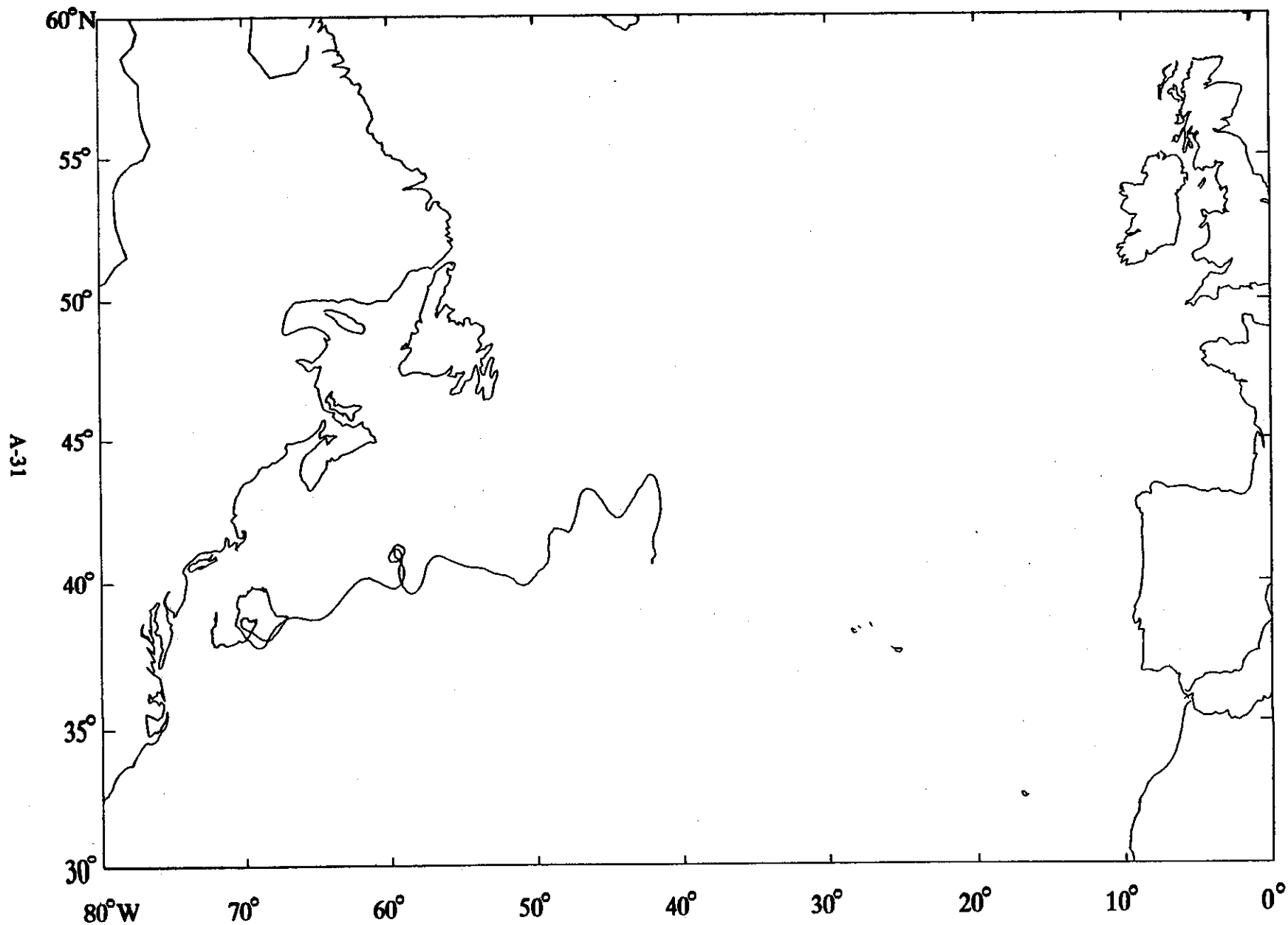


Figure A-10(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12760. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-11(a). Trajectory of drifter number 12761 deployed on December 3, 1990.
Last transmission received on April 4, 1991.**

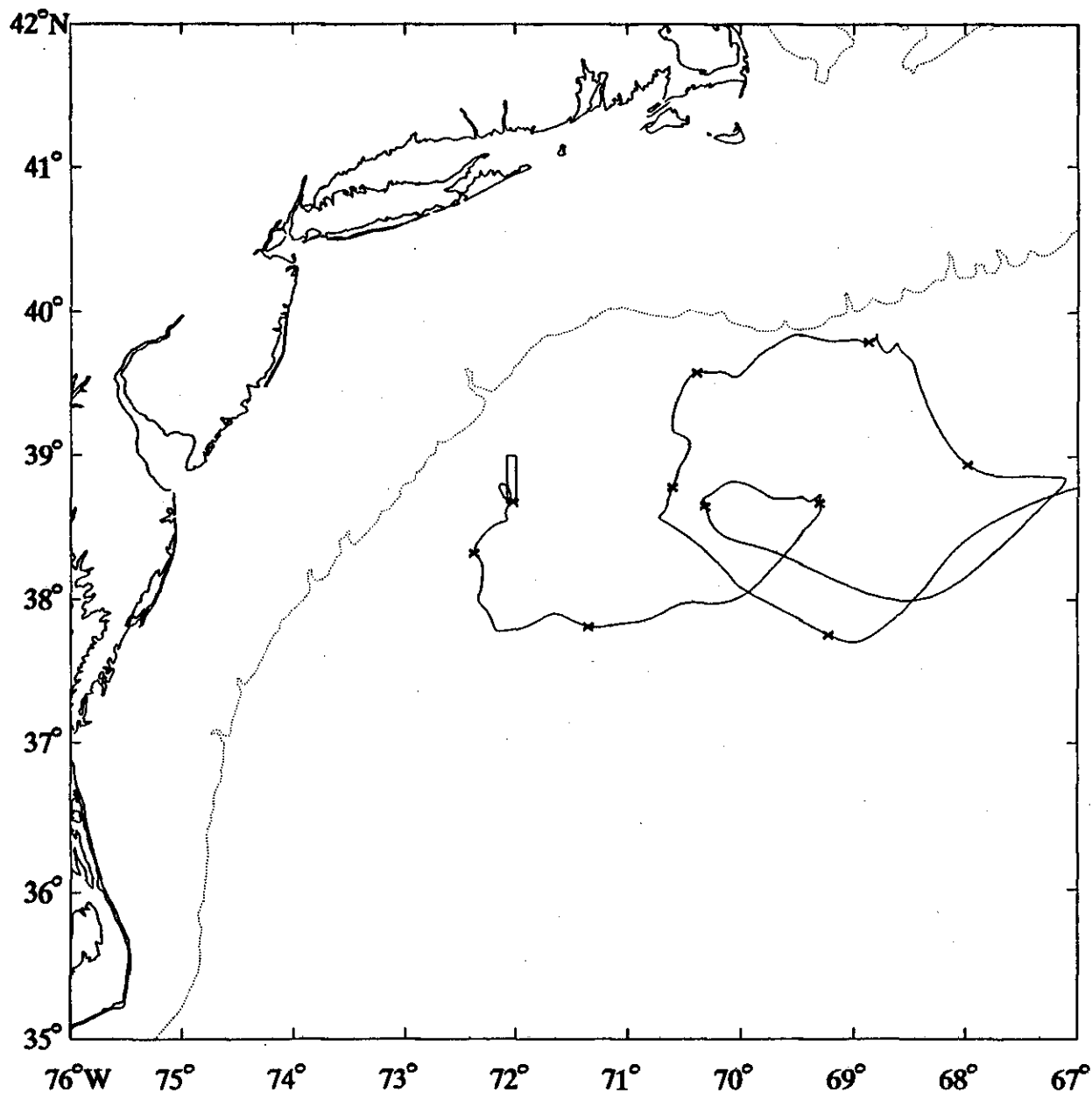


Figure A-11(b). Trajectory of drifter number 12761 deployed on December 3, 1990, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

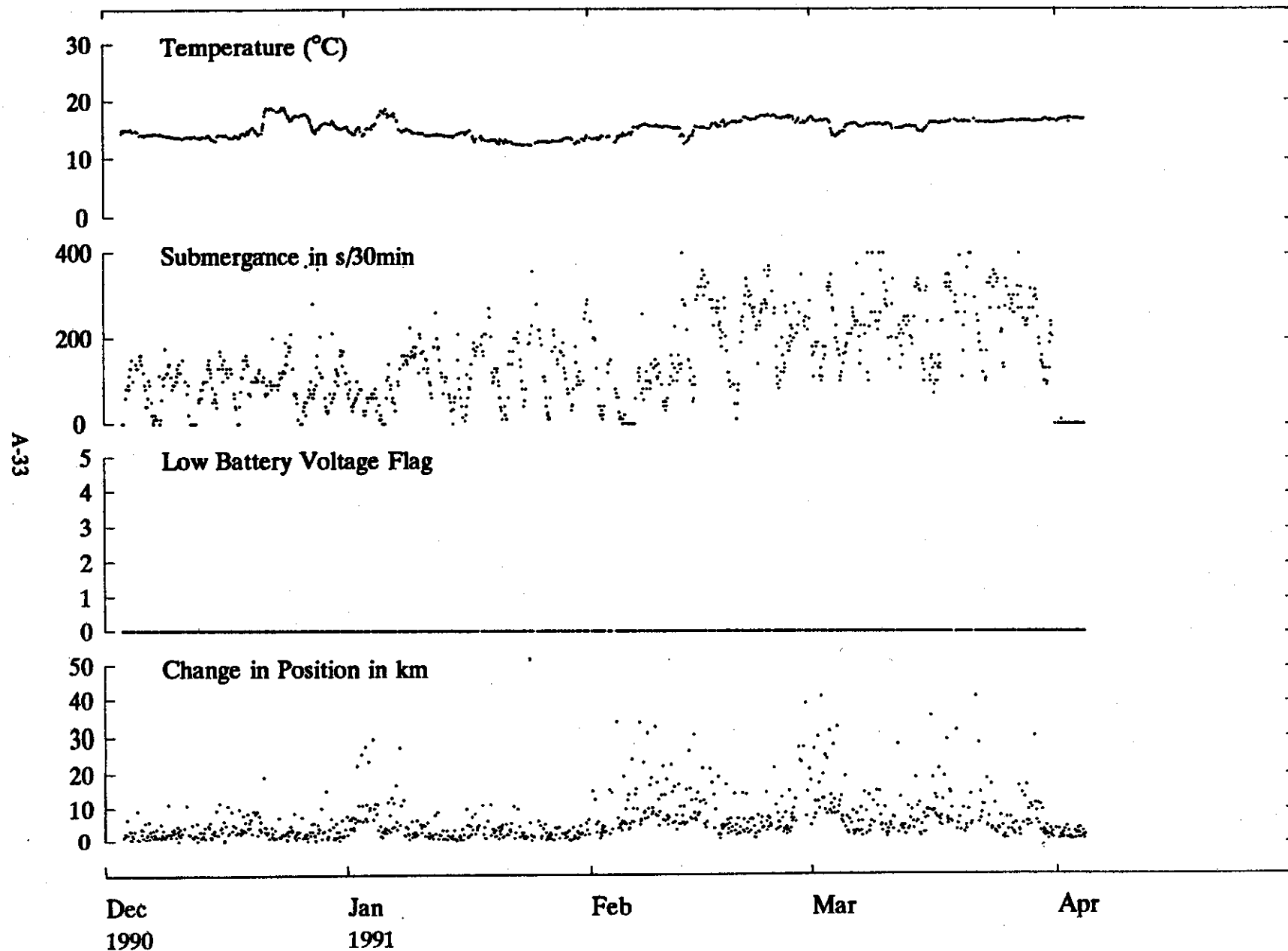
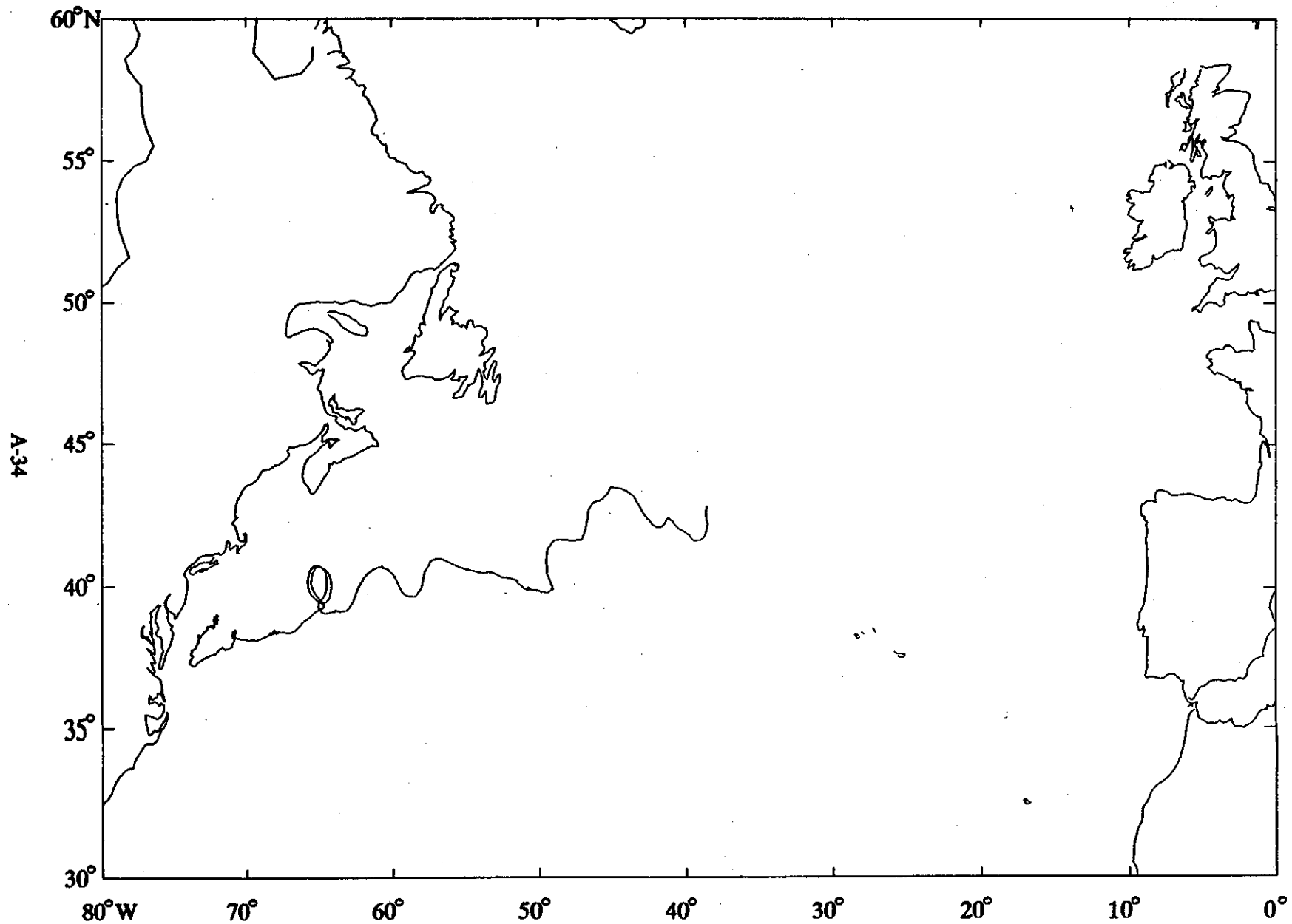


Figure A-11(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12761. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-12(a). Trajectory of drifter number 12762 deployed on December 8, 1990.
Last transmission received on April 10, 1991.**

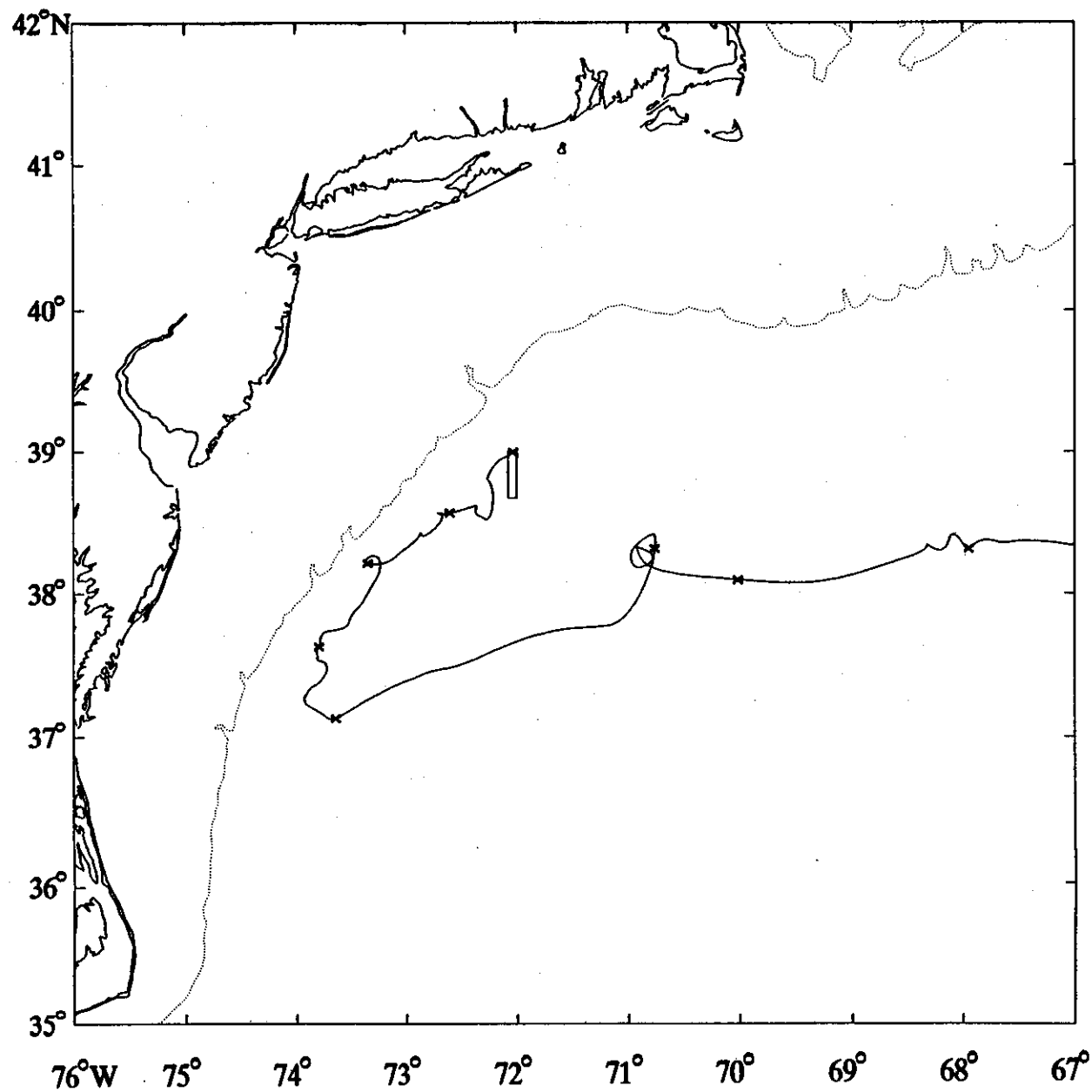


Figure A-12(b). Trajectory of drifter number 12762 deployed on December 8, 1990, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

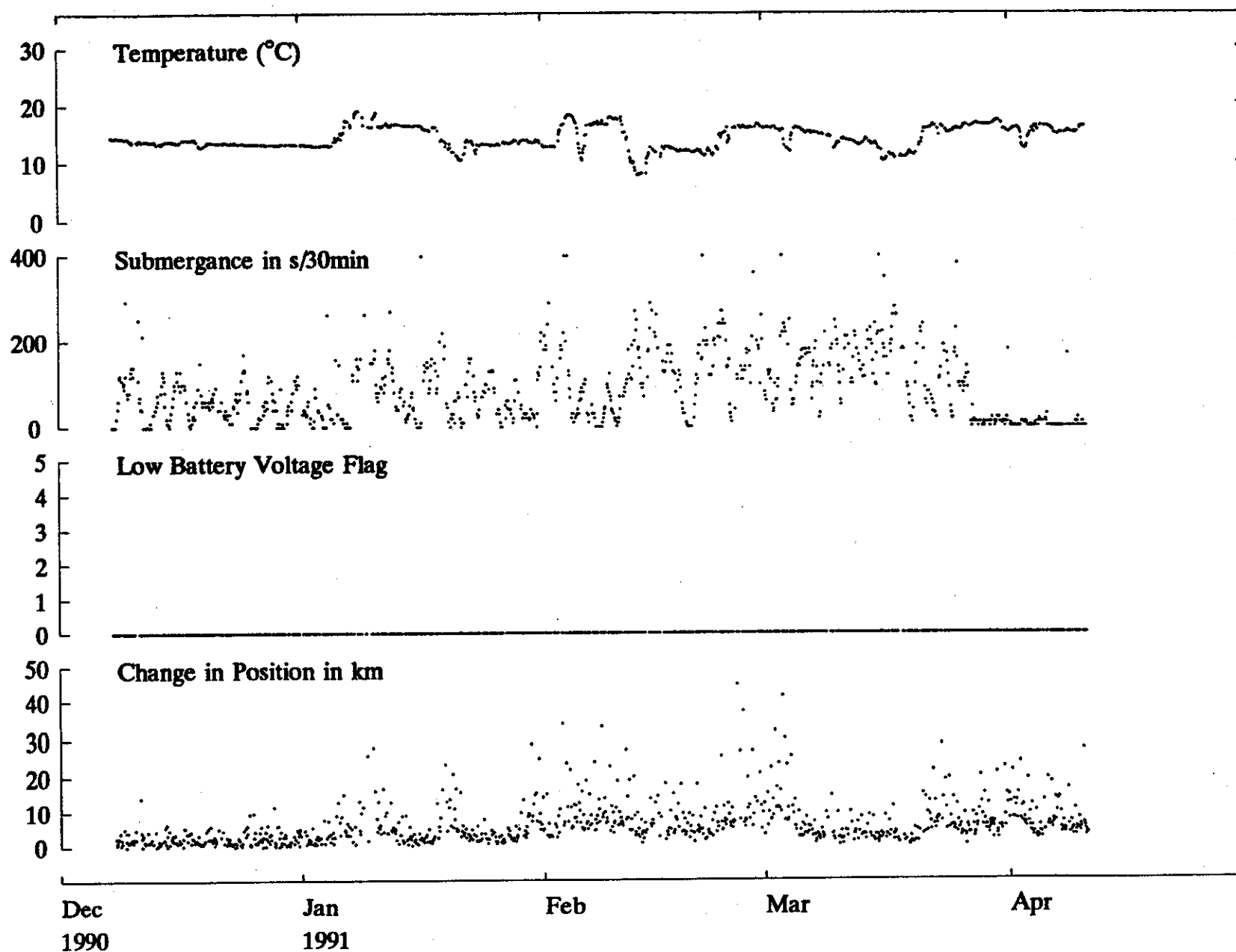
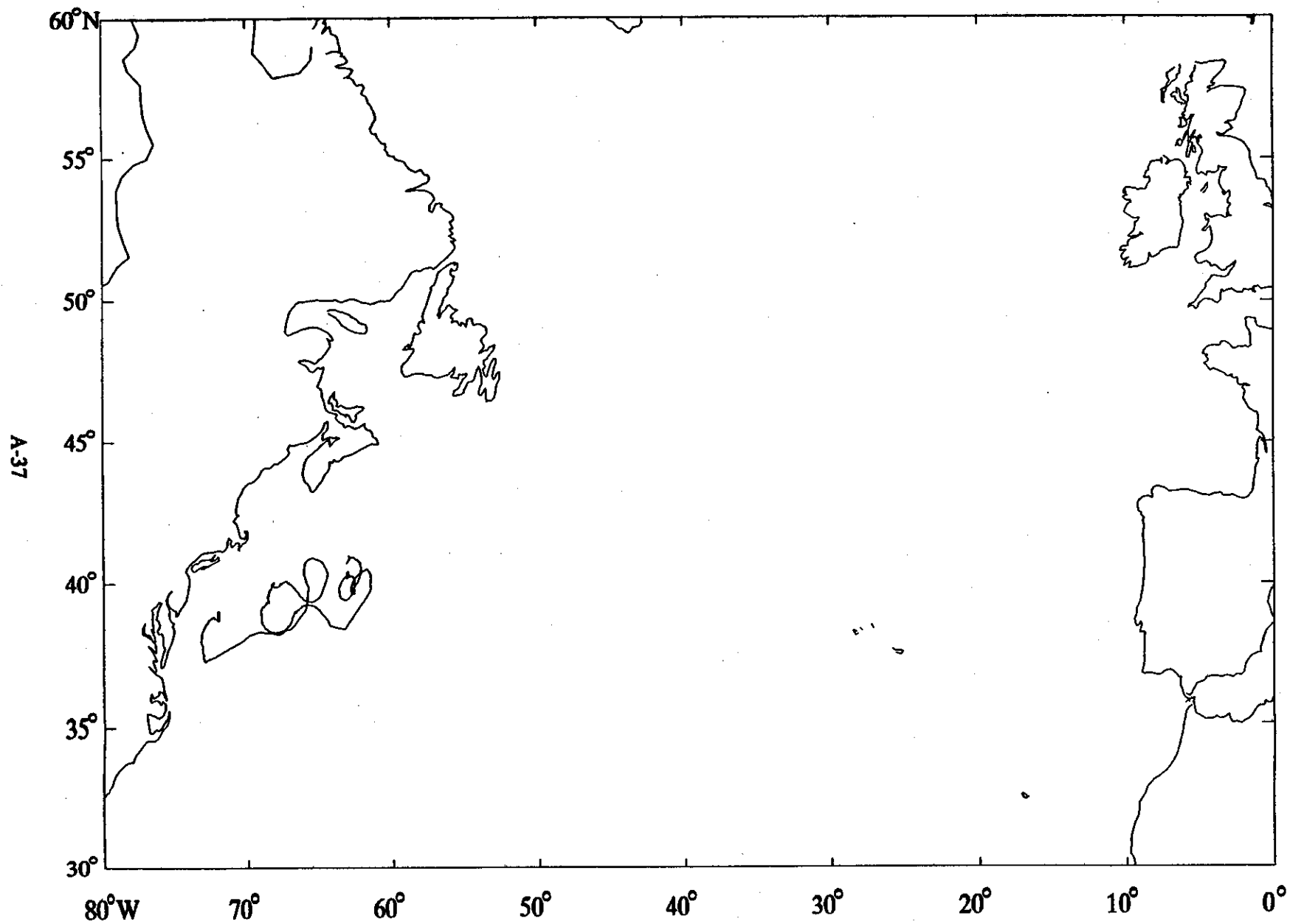


Figure A-12(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12762. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-13(a). Trajectory of drifter number 12763 deployed on November 4, 1990.
Last transmission received on March 7, 1991.**

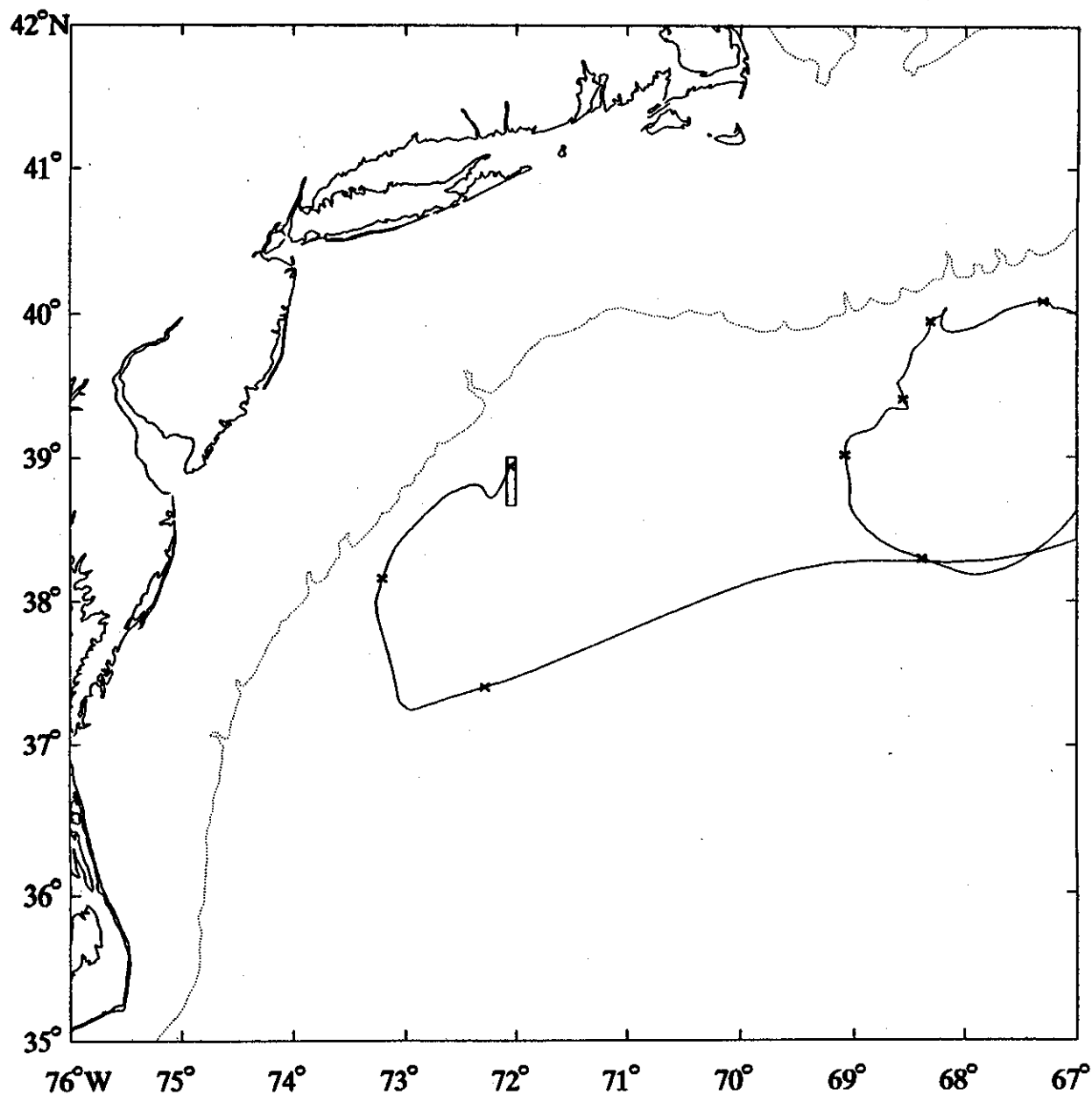


Figure A-13(b). Trajectory of drifter number 12763 deployed on November 4, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

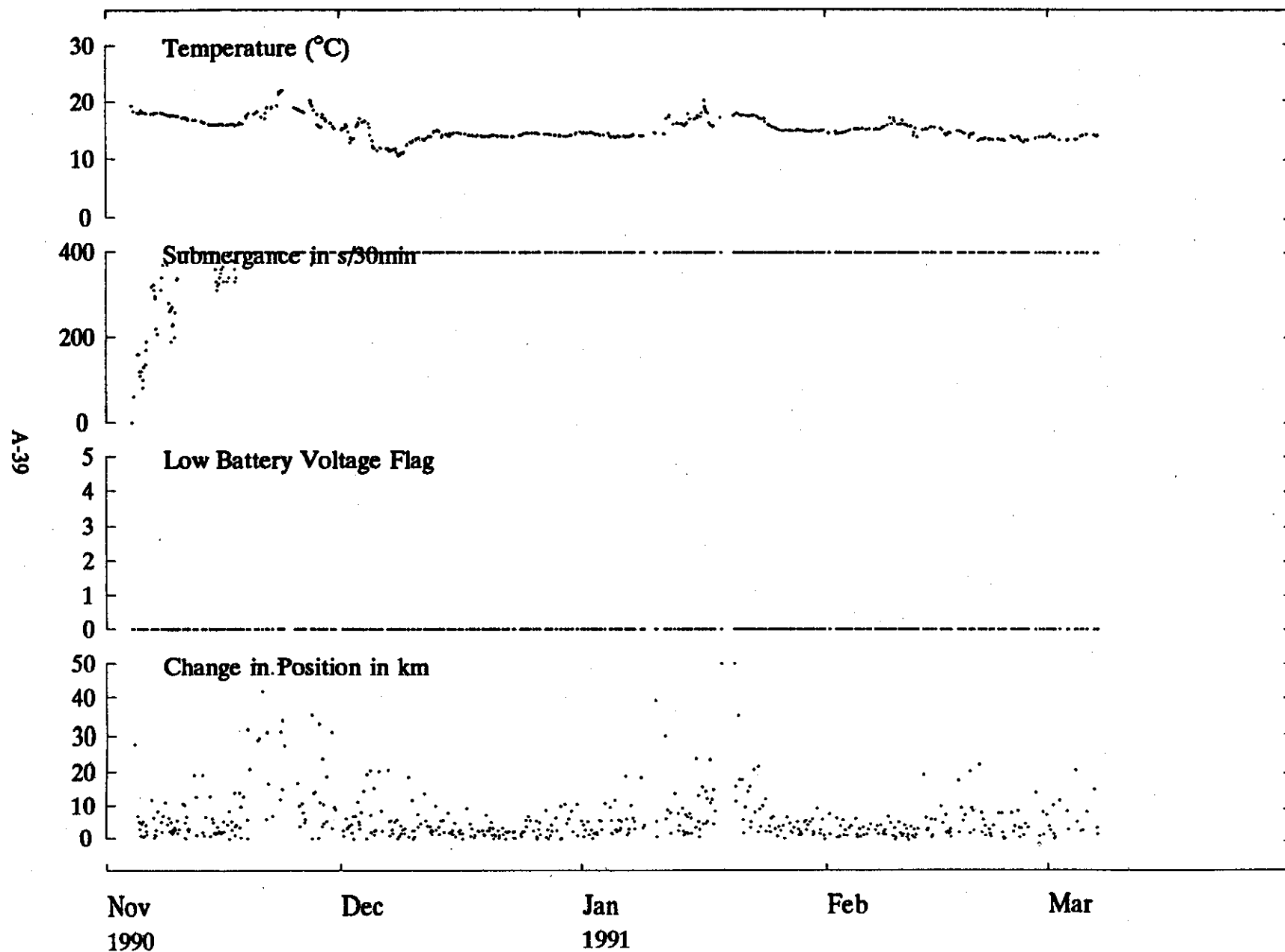
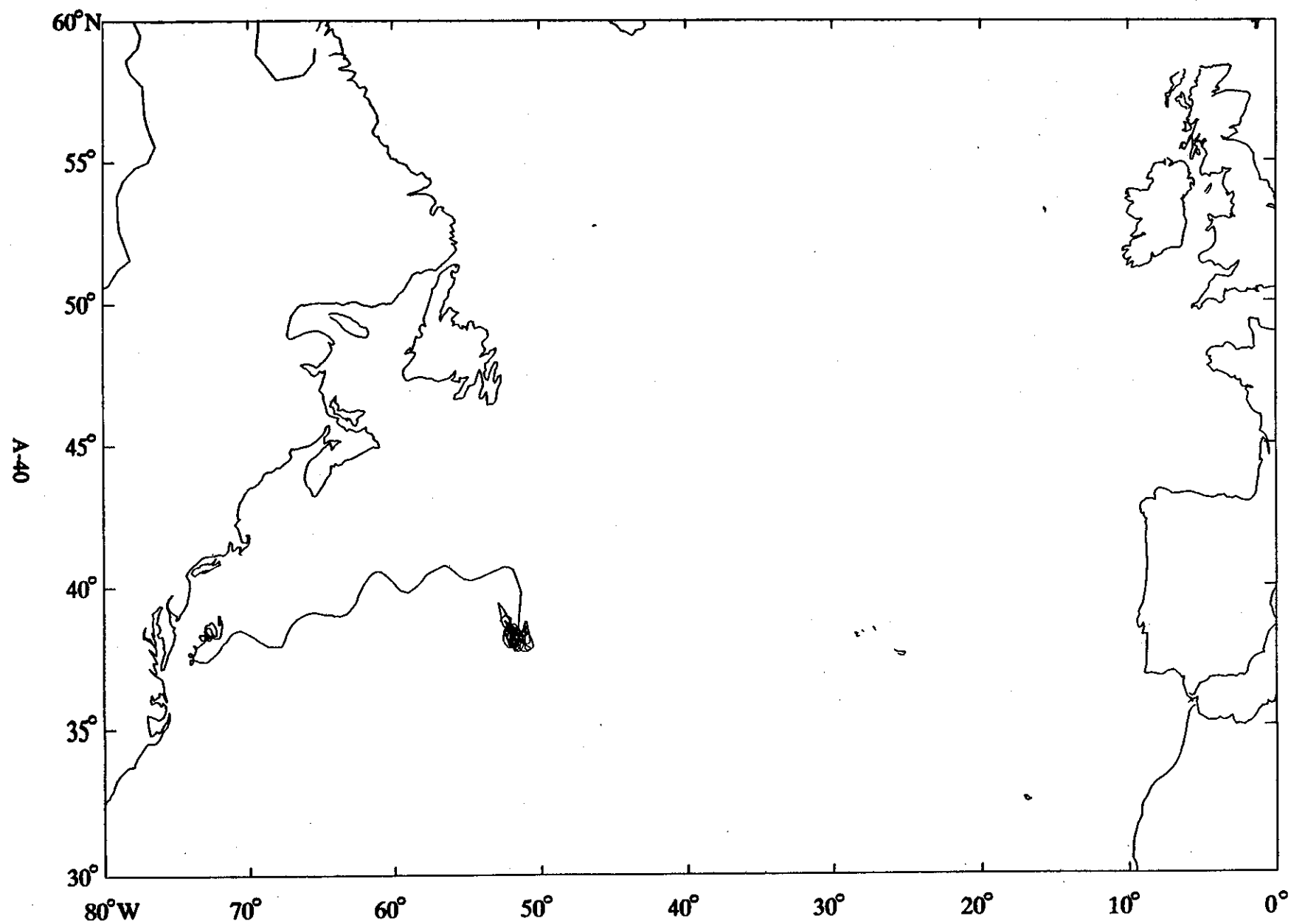


Figure A-13(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12763. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-14(a). Trajectory of drifter number 12764 deployed on January 8, 1991.
Last transmission received on May 11, 1991.**

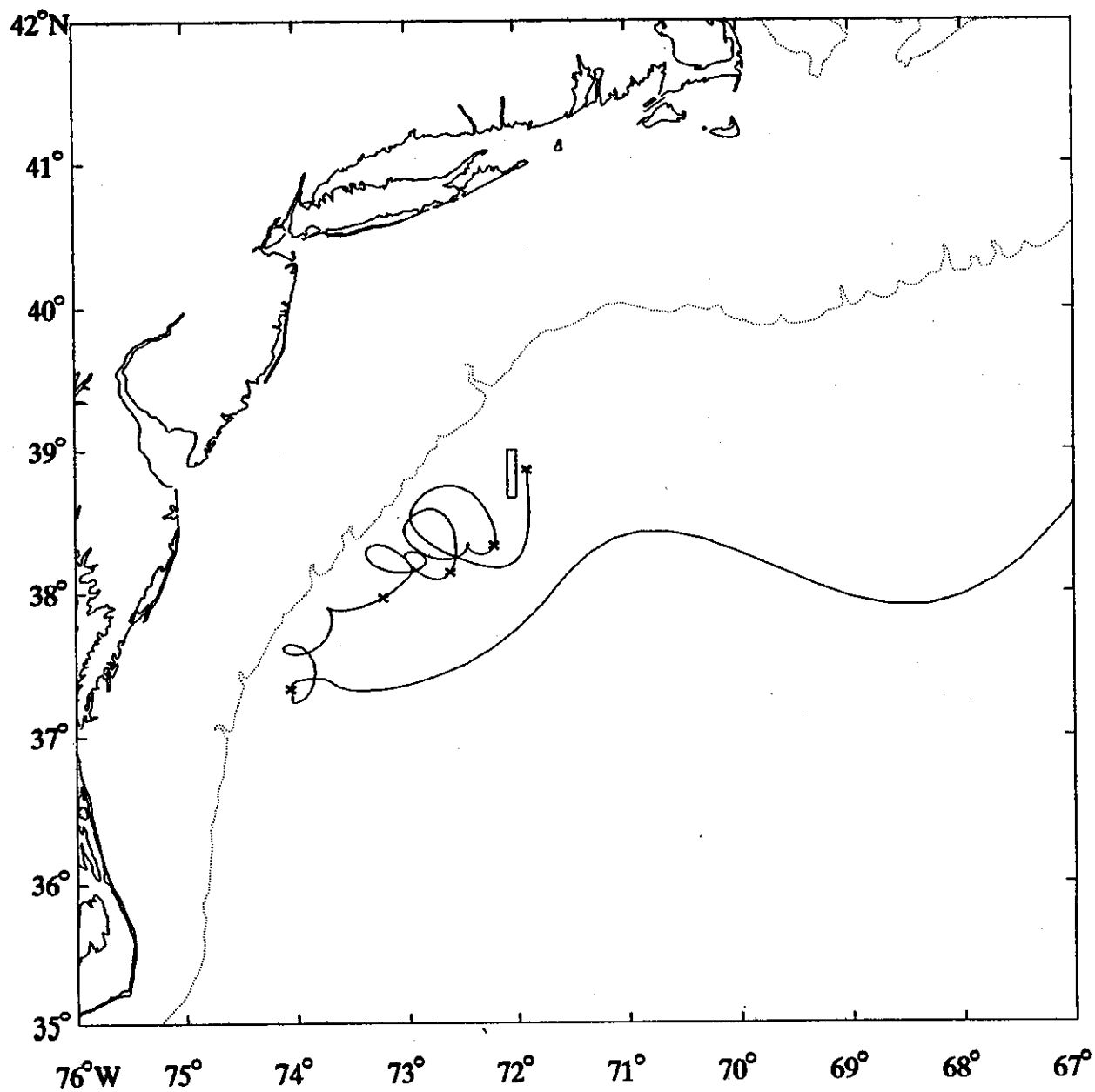


Figure A-14(b). Trajectory of drifter number 12764 deployed on January 8, 1991, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

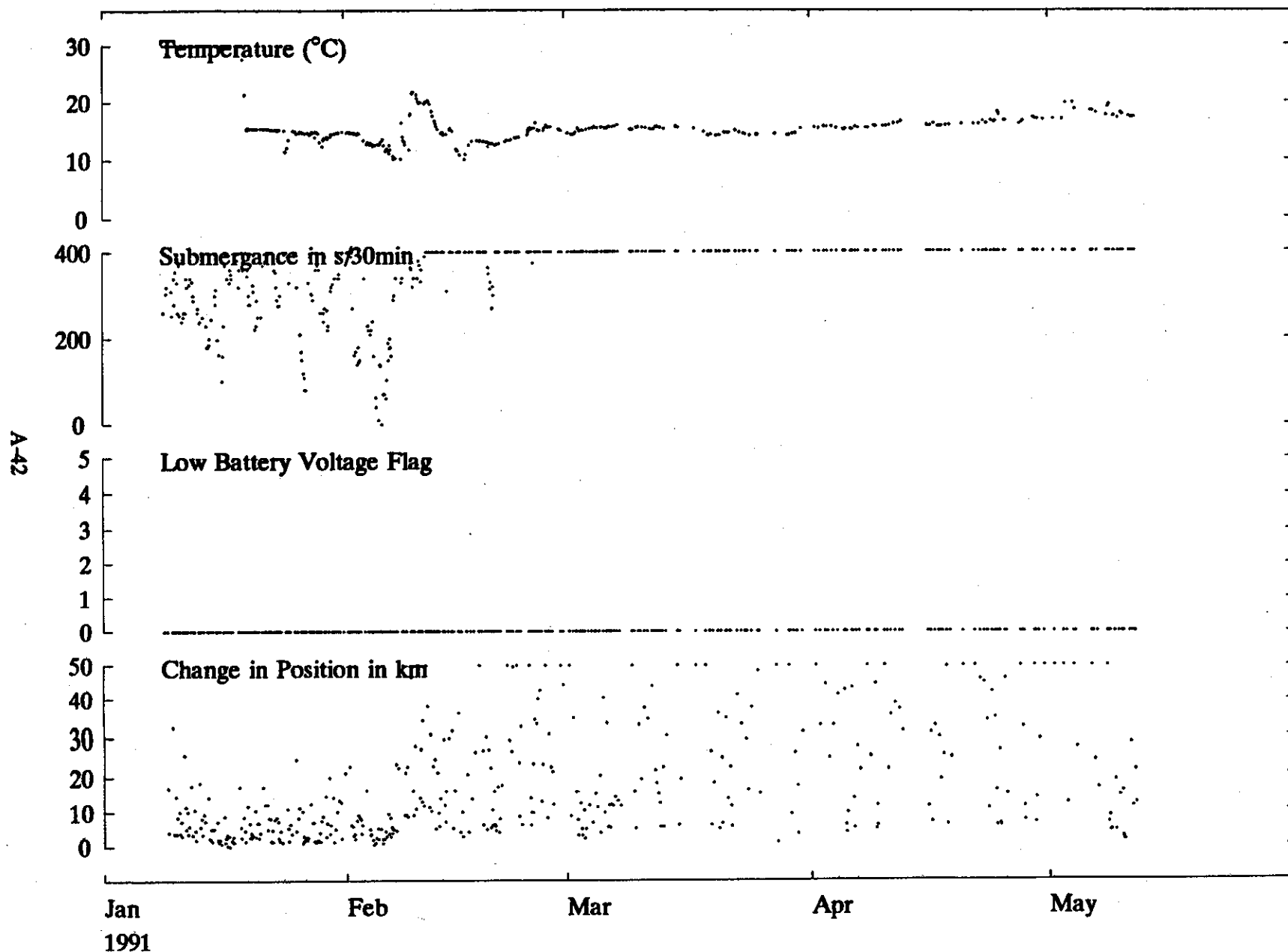
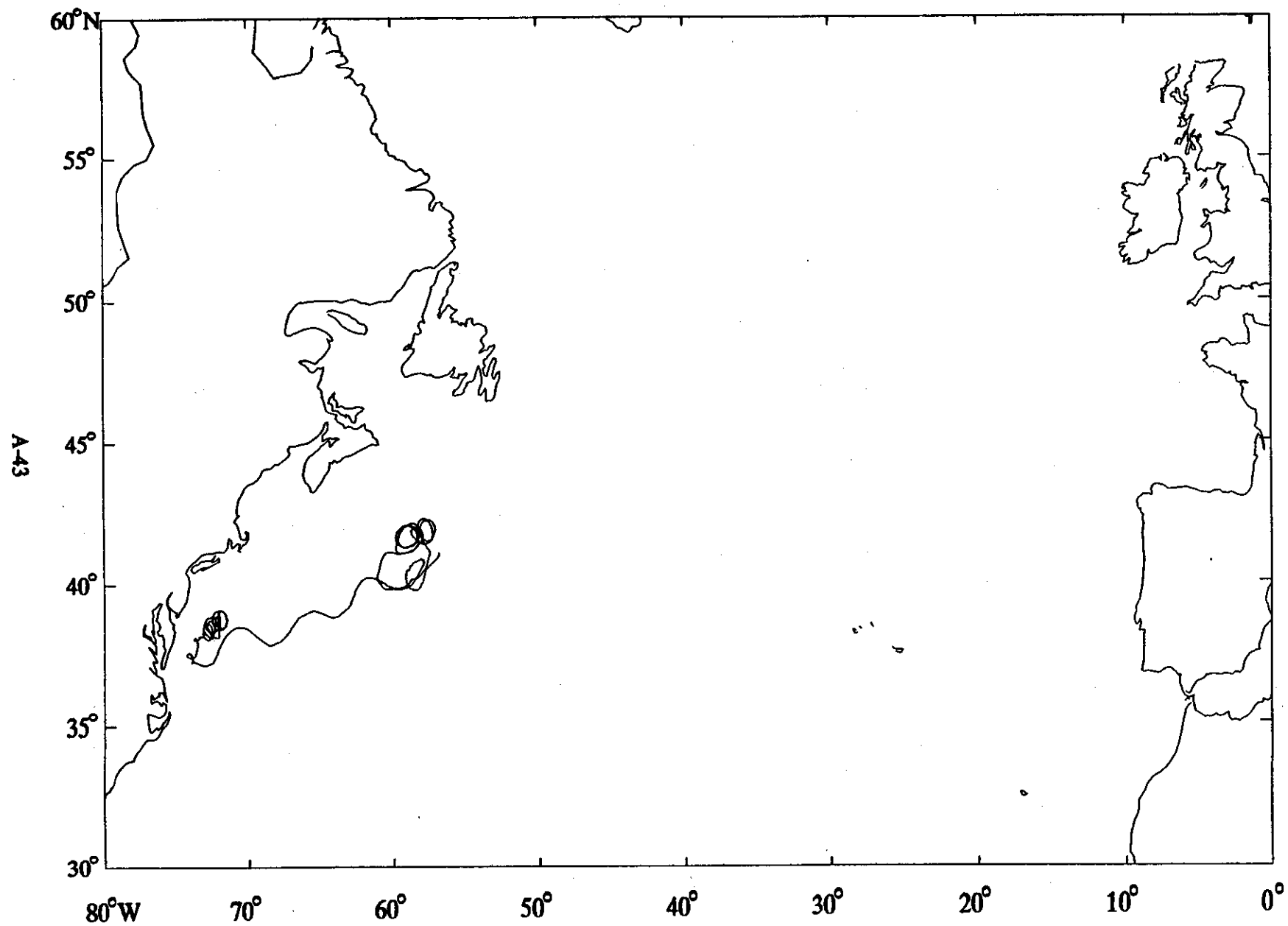


Figure A-14(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12764. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-15(a). Trajectory of drifter number 12765 deployed on December 22, 1990.
Last transmission received on April 24, 1991.**

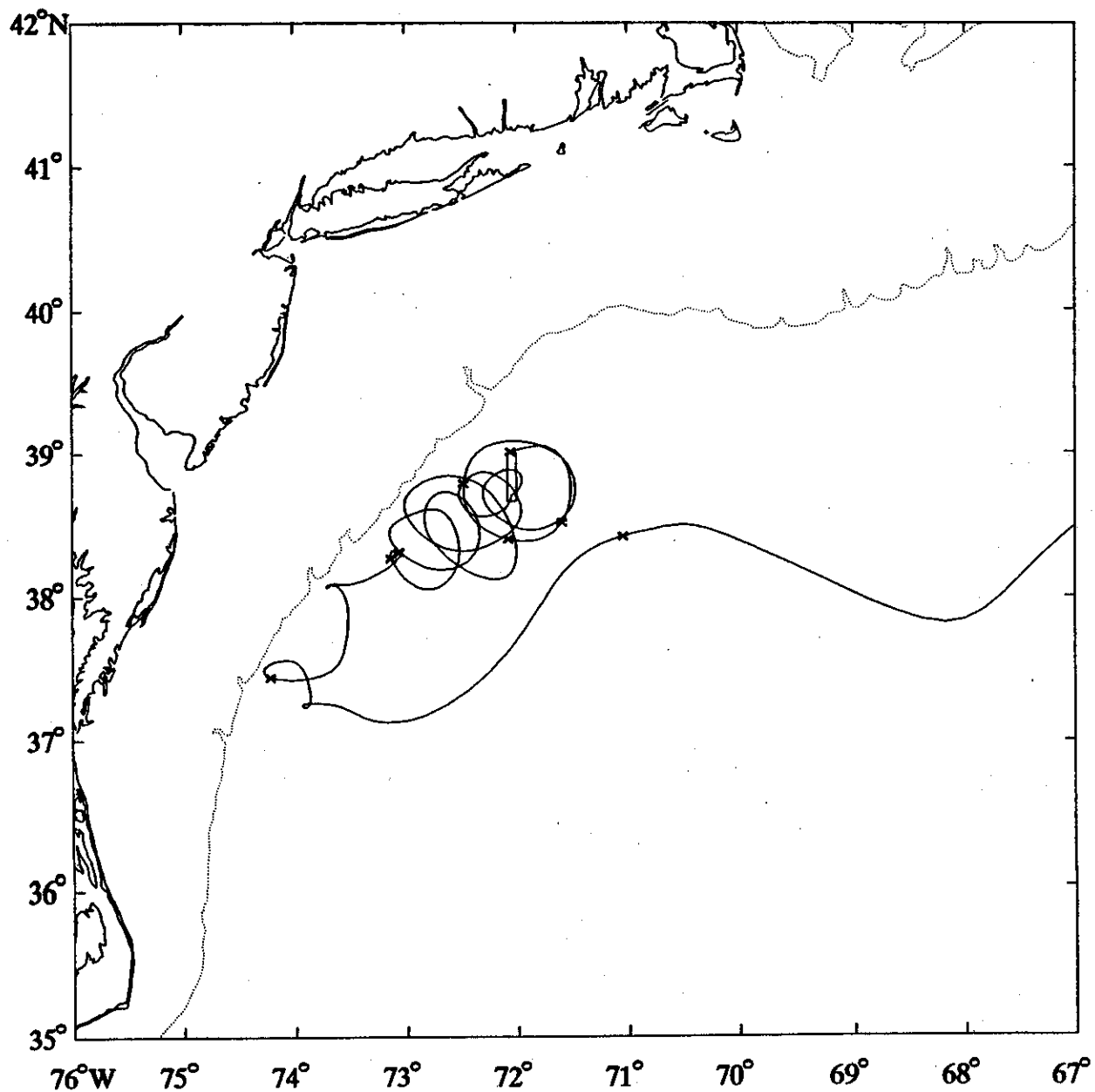


Figure A-15(b). Trajectory of drifter number 12765 deployed on December 22, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

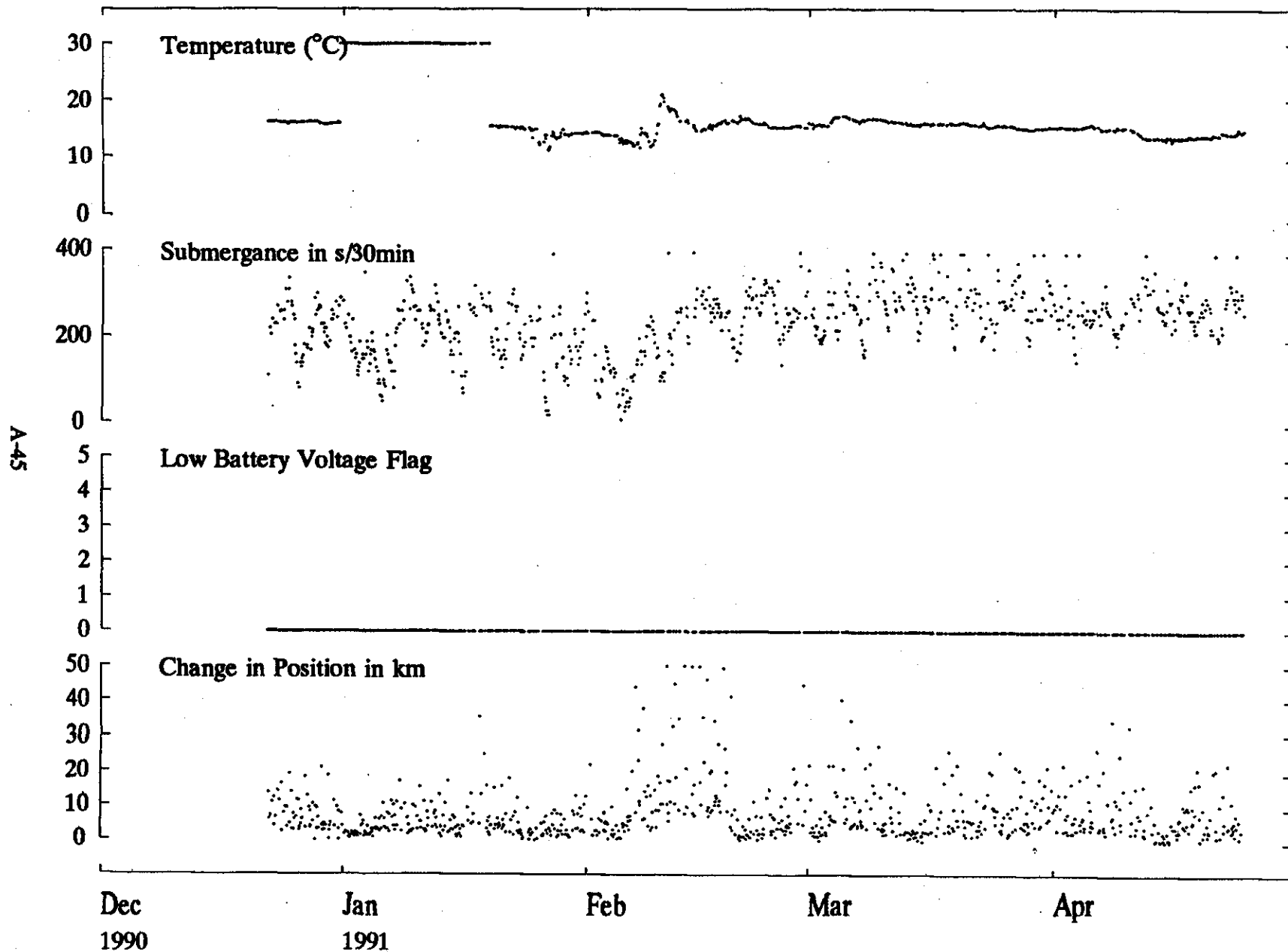
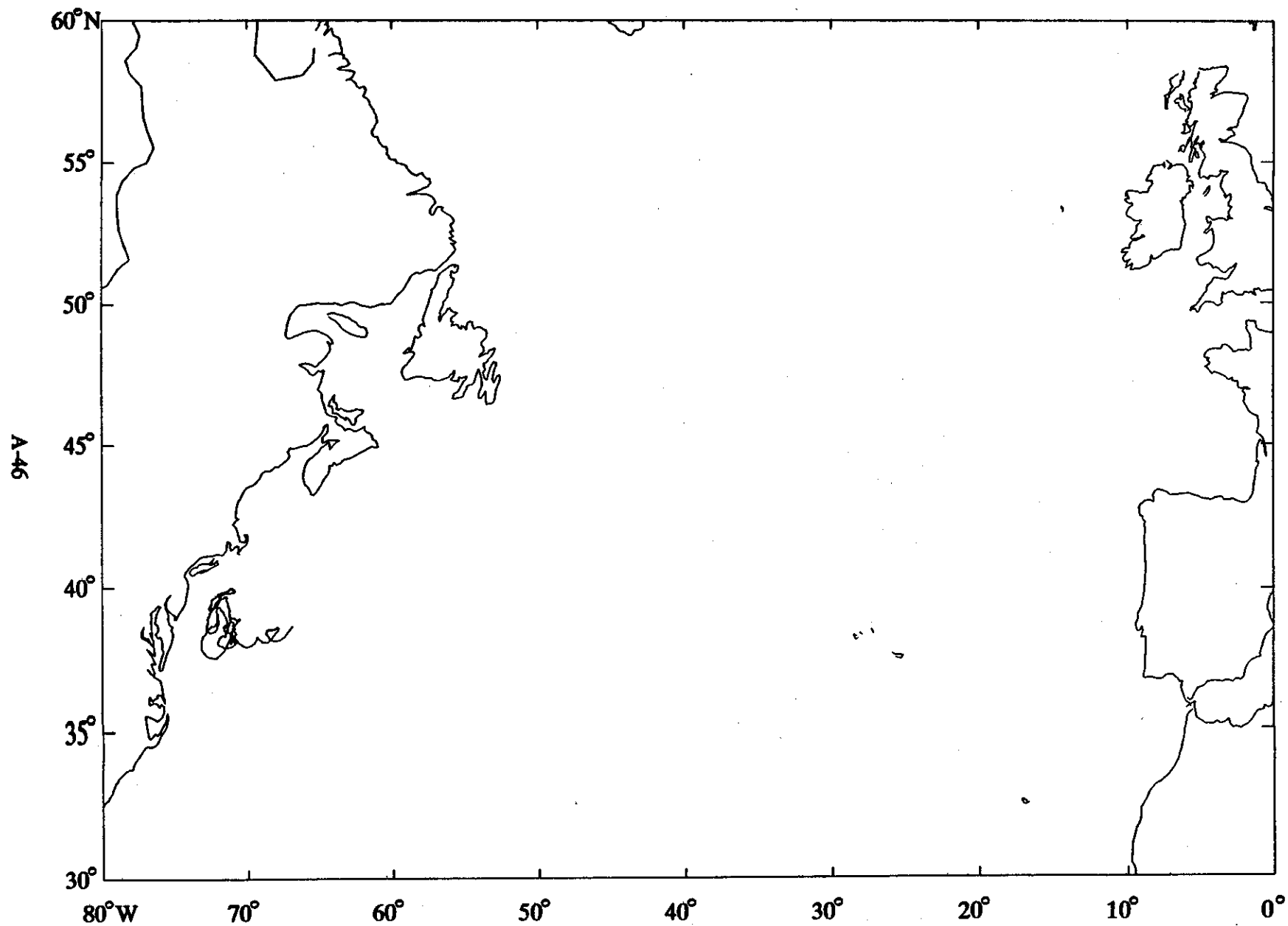


Figure A-15(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12765. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-16(a). Trajectory of drifter number 12766 deployed on February 8, 1991.
Last transmission received on June 12, 1991.**

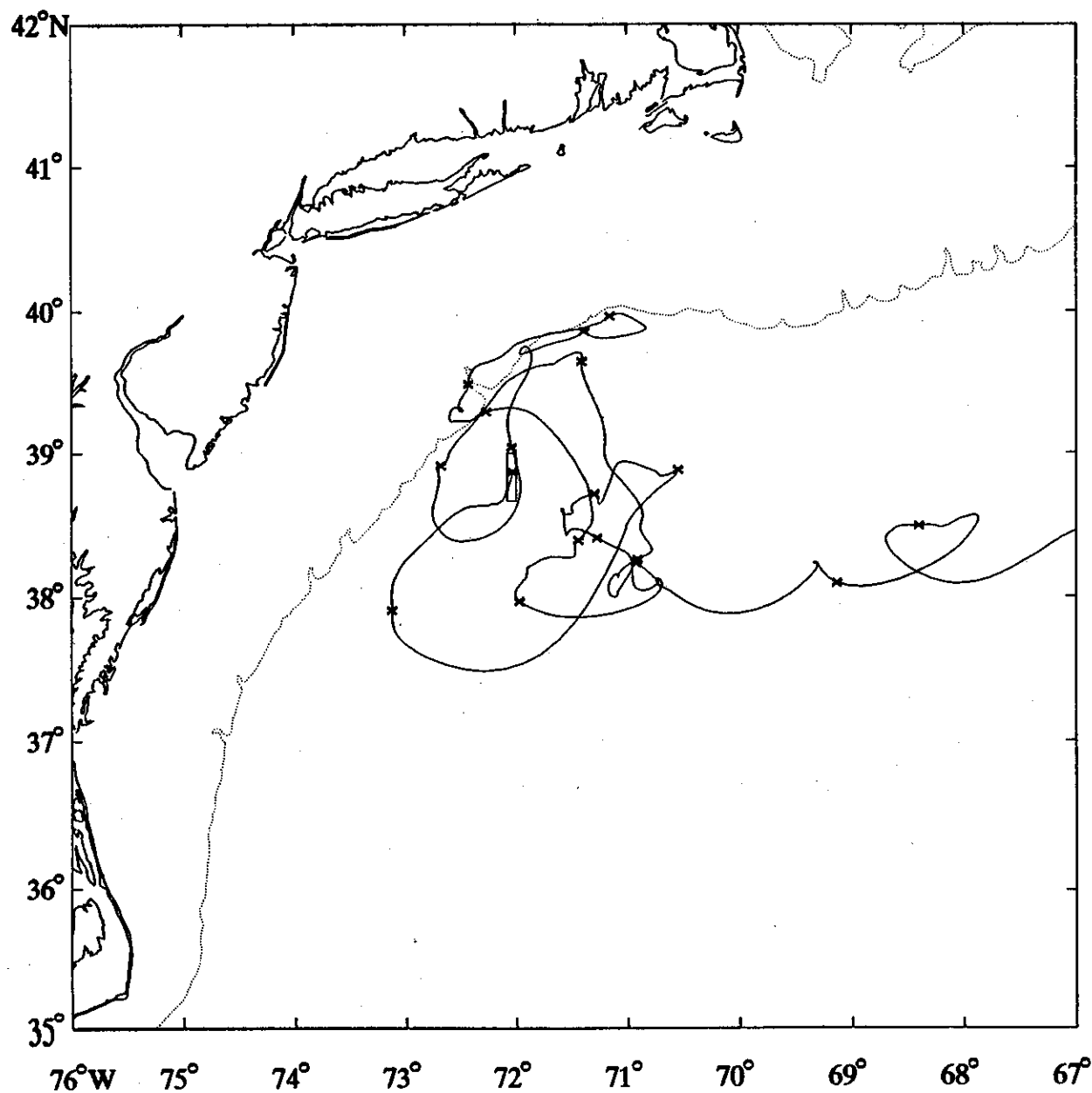


Figure A-16(b). Trajectory of drifter number 12766 deployed on February 8, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

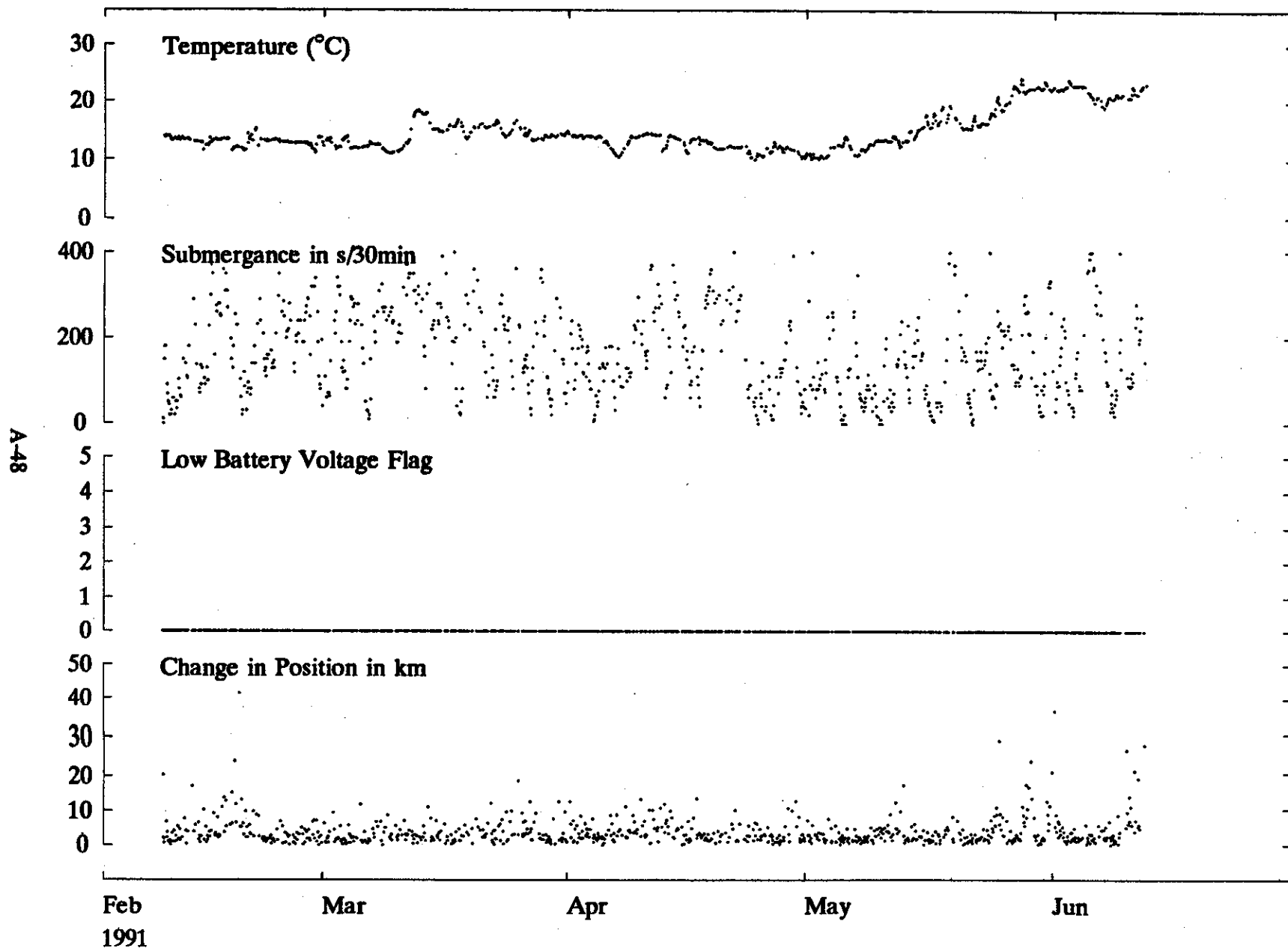
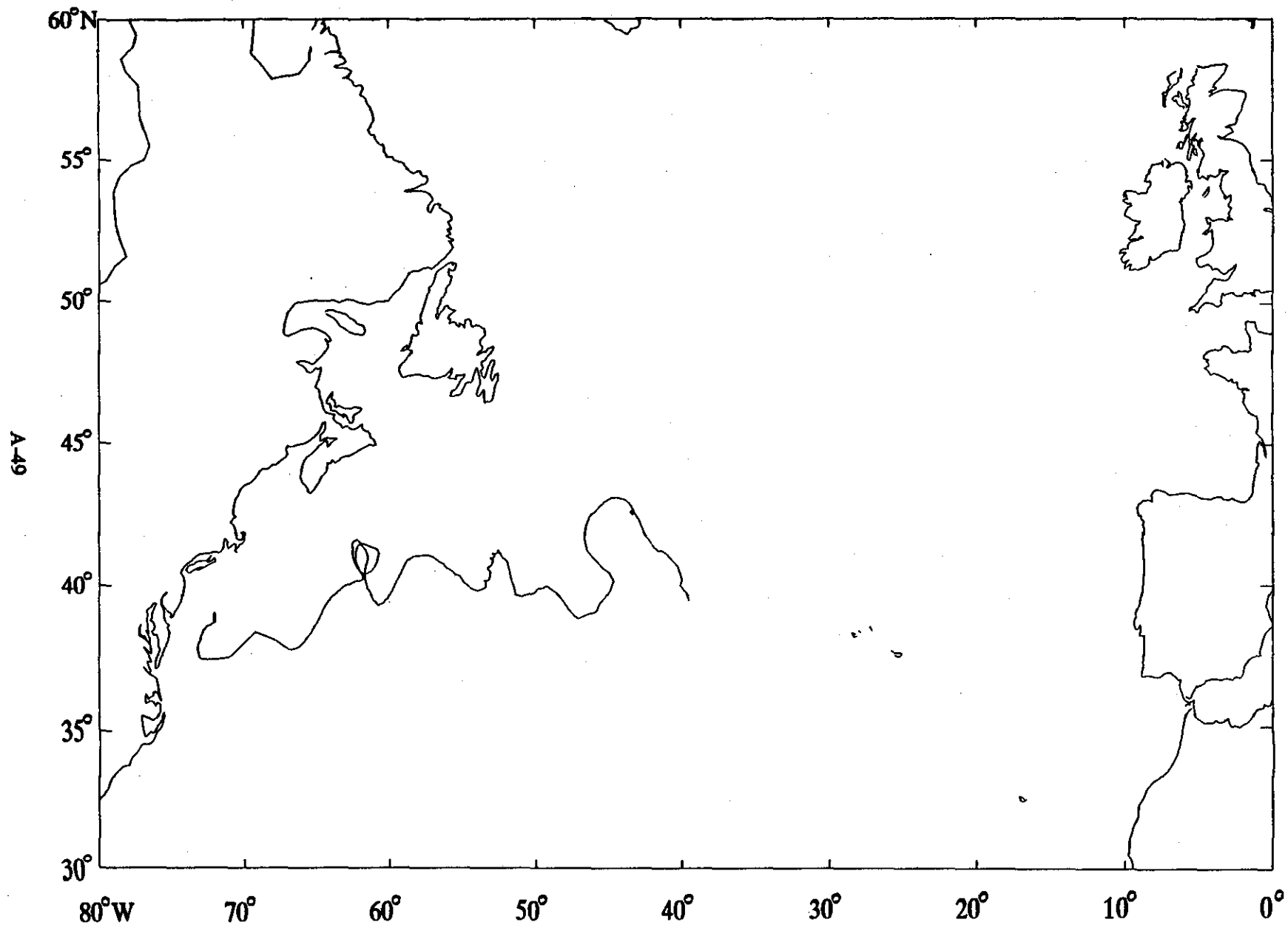


Figure A-16(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12766. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-17(a). Trajectory of drifter number 12767 deployed on March 13, 1991.
Last transmission received on June 28, 1991.**

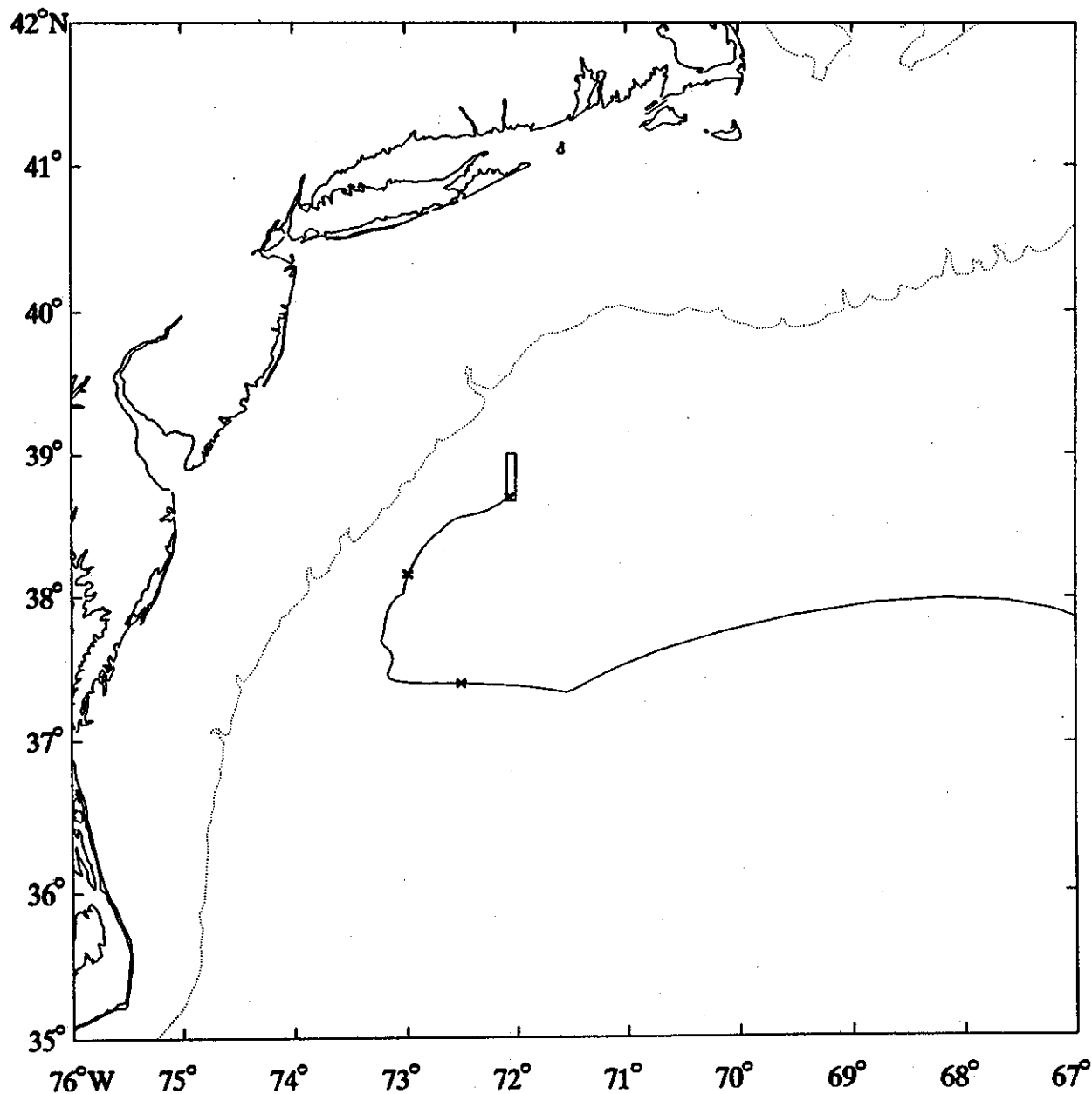


Figure A-17(b). Trajectory of drifter number 12767 deployed on March 13, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

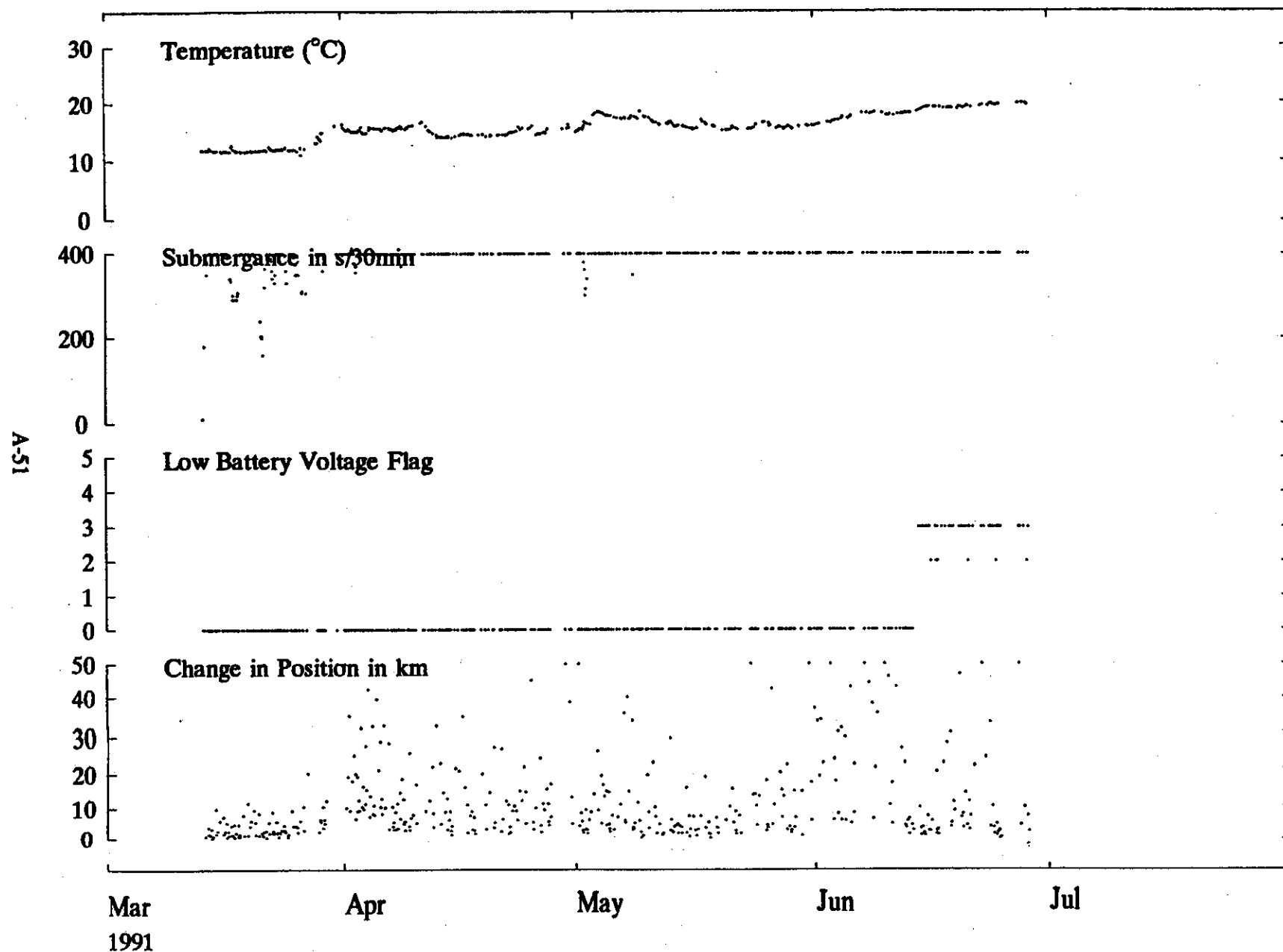
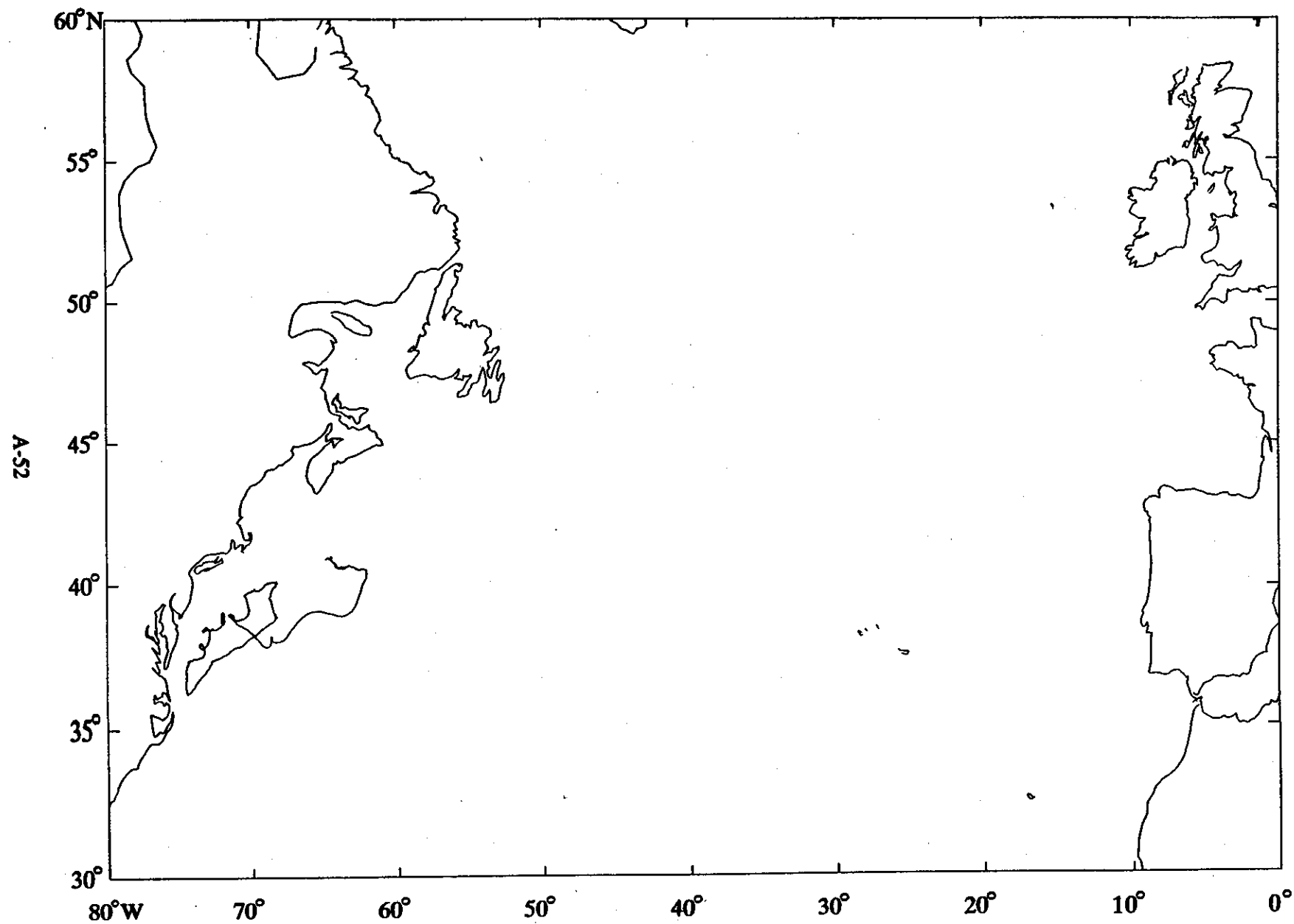


Figure A-17(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12767. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-18(a). Trajectory of drifter number 12768 deployed on November 8, 1990.
Last transmission received on March 12, 1991.**

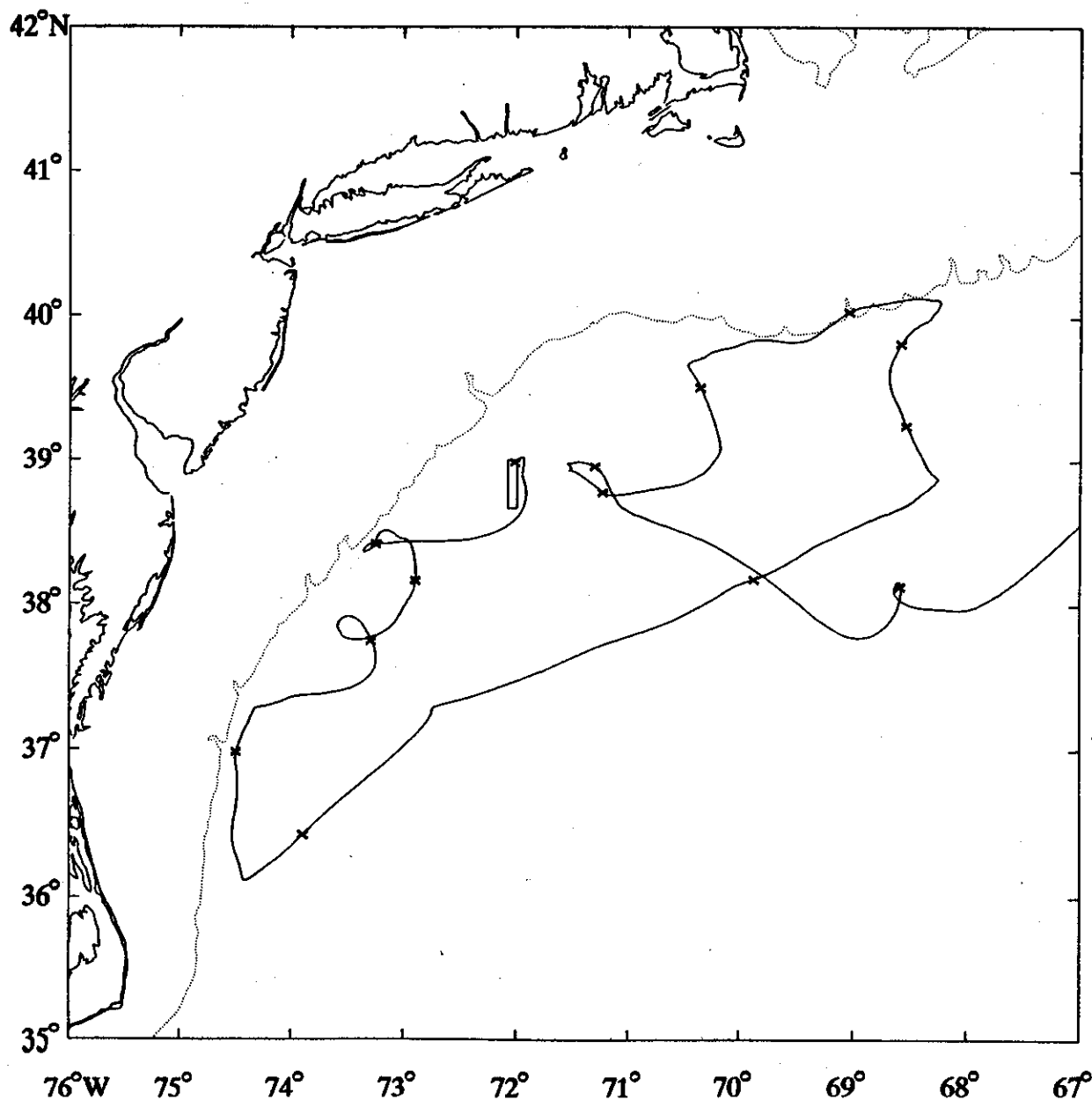


Figure A-18(b). Trajectory of drifter number 12768 deployed on November 8, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

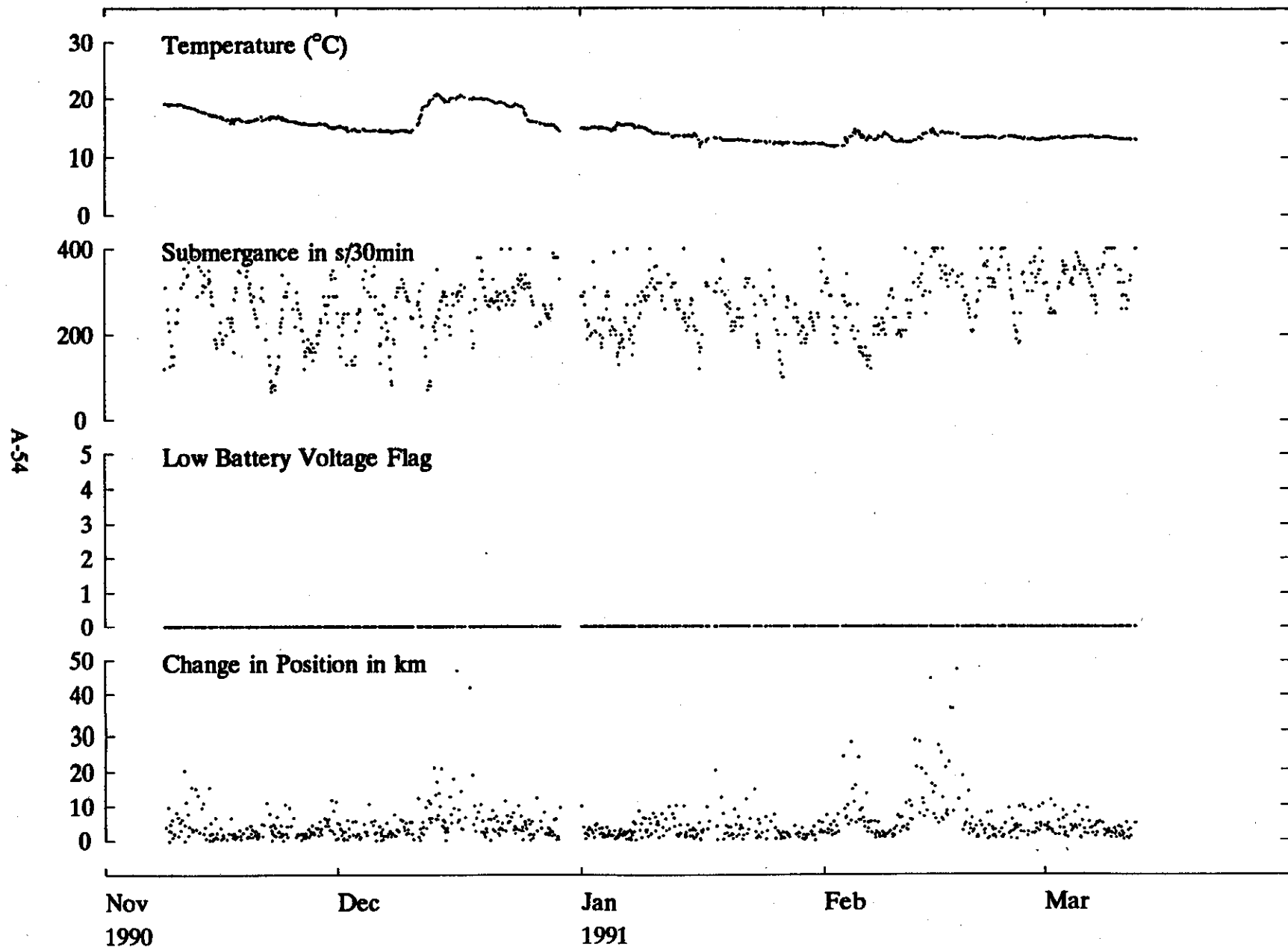


Figure A-18(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12768. The data have been quality-assured, removing transmission errors and wild points.

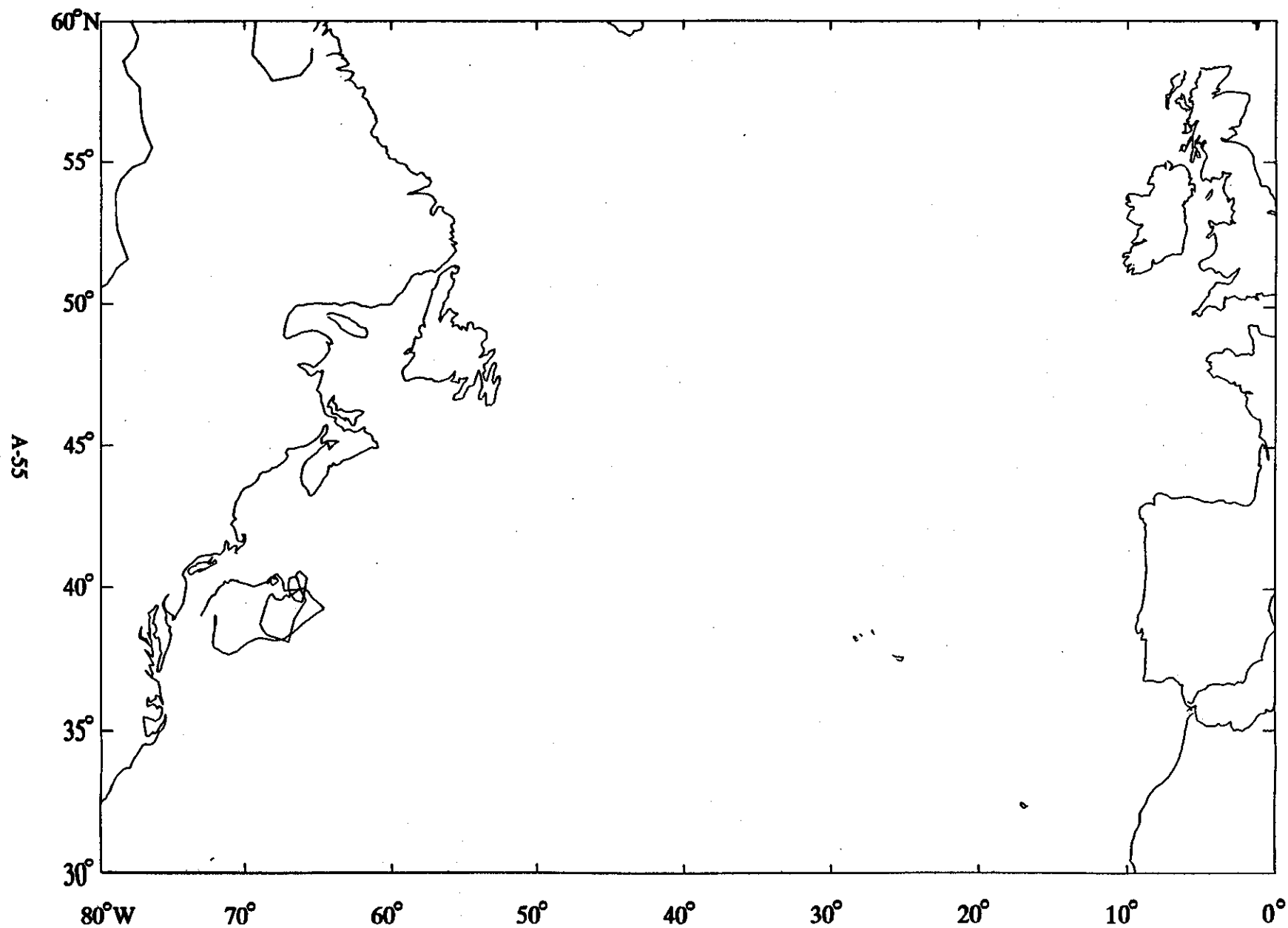


Figure A-19(a). Trajectory of drifter number 12769 deployed on January 20, 1991.
Last transmission received on May 23, 1991.

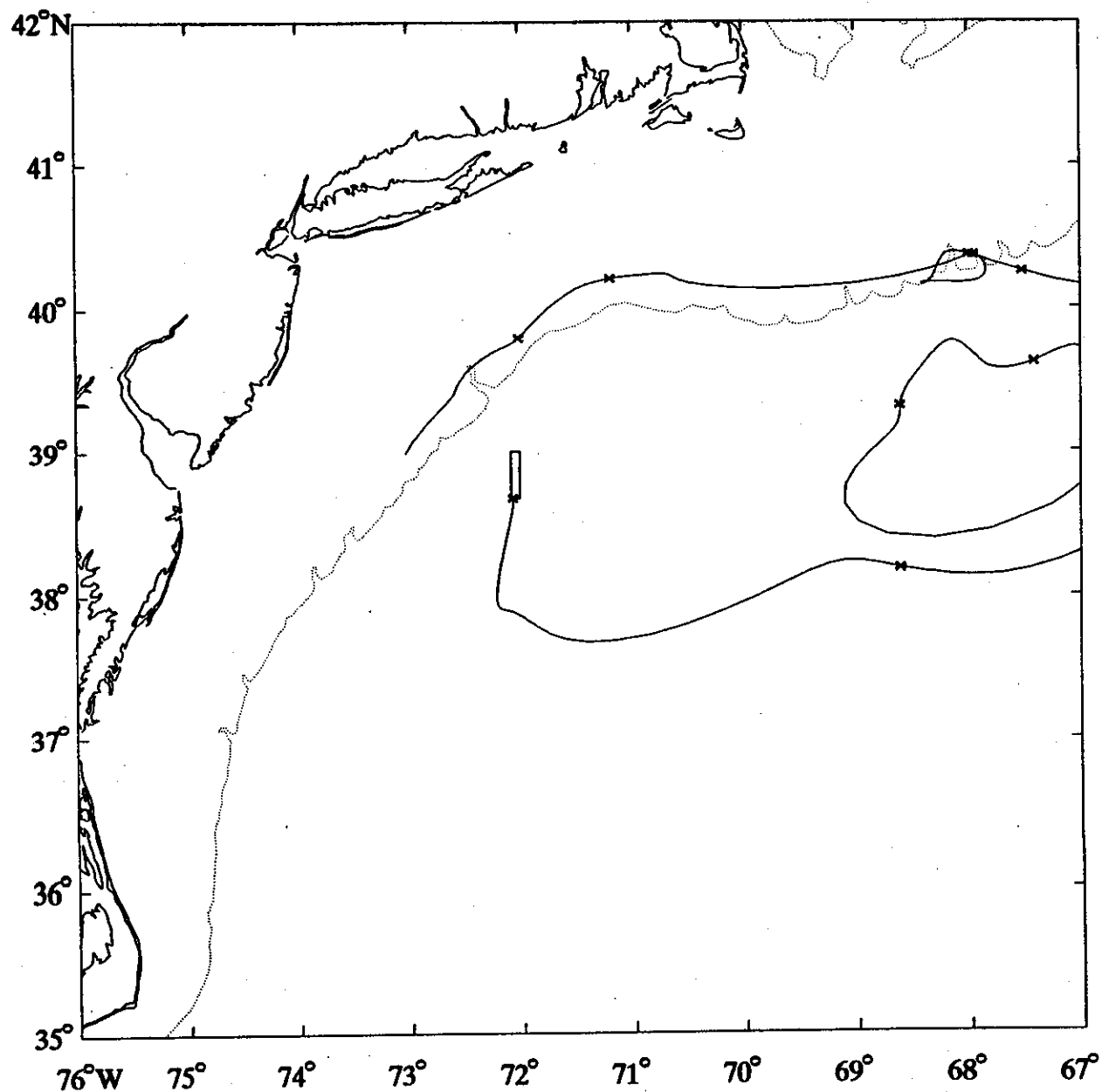


Figure A-19(b). Trajectory of drifter number 12769 deployed on January 20, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

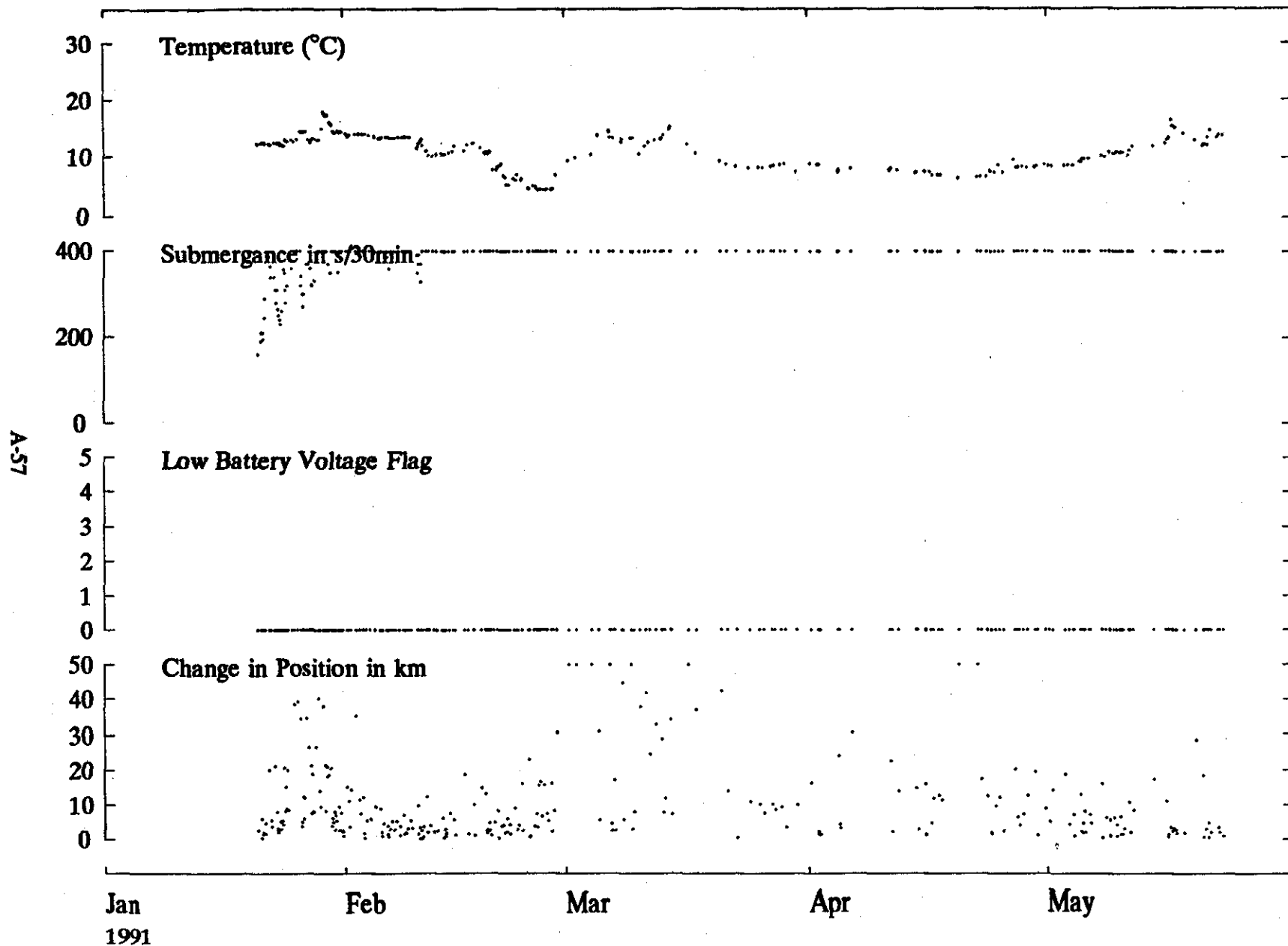
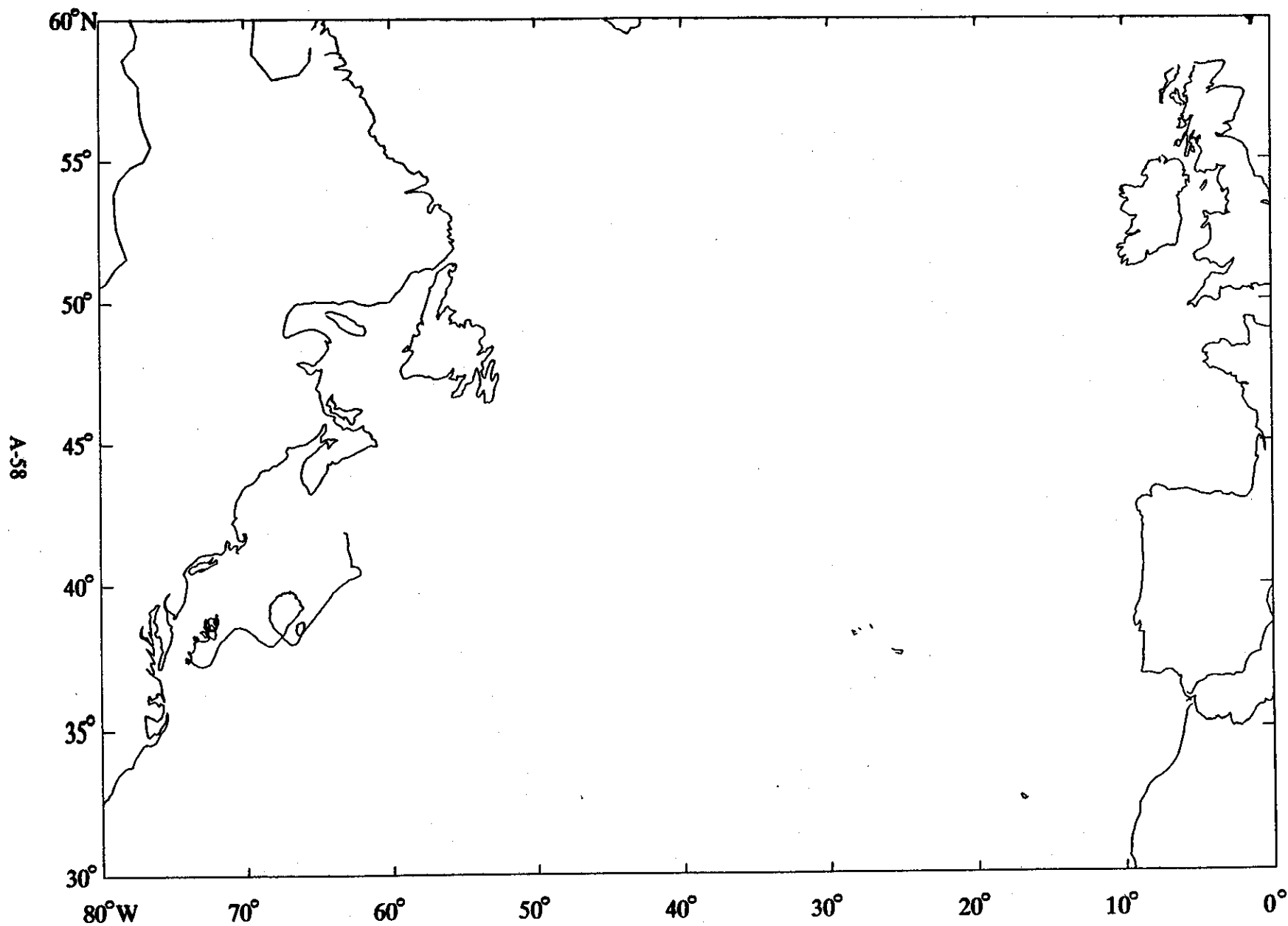


Figure A-19(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12769. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-20(a). Trajectory of drifter number 12770 deployed on December 27, 1990.
Last transmission received on April 26, 1991.**

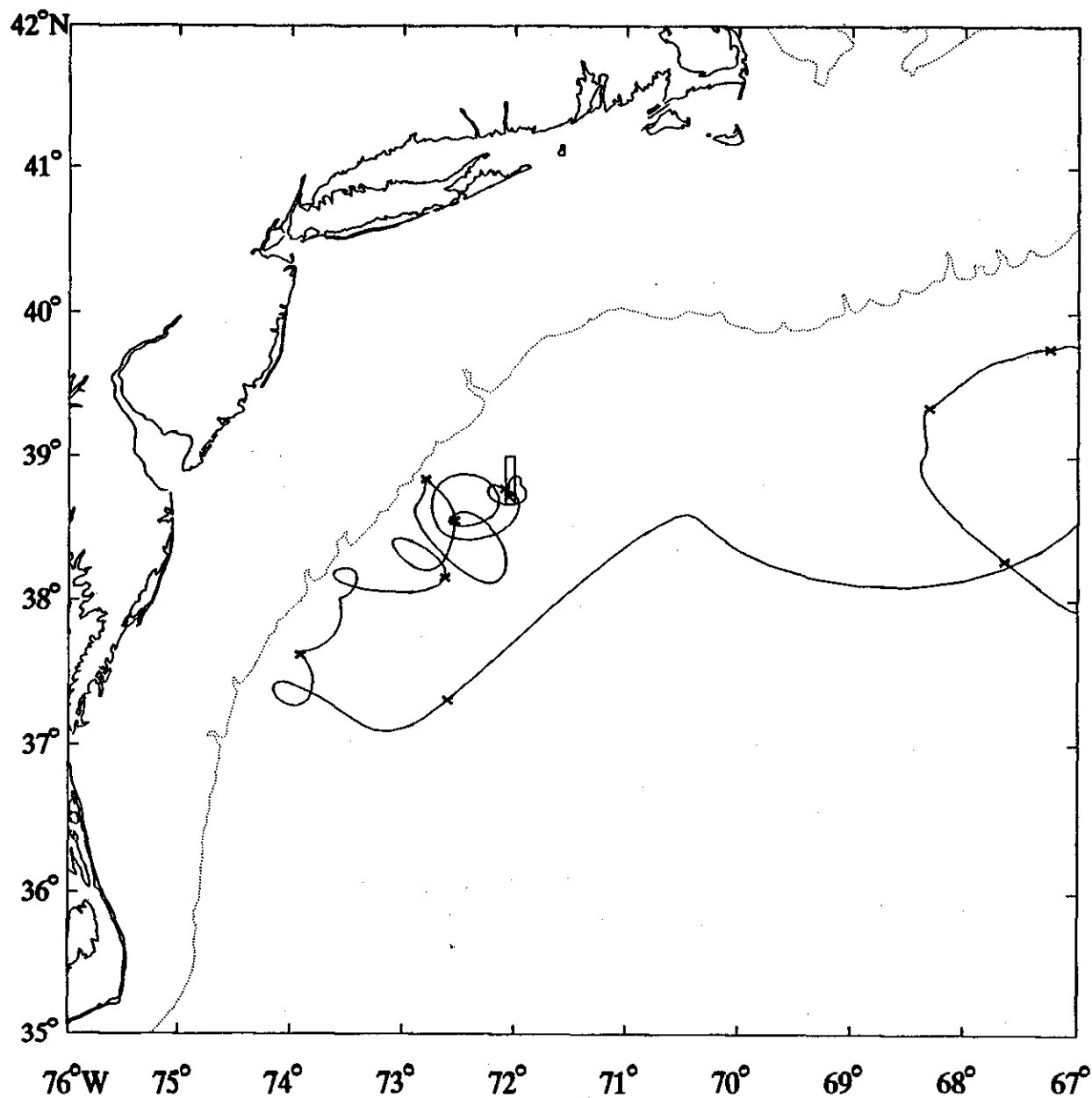


Figure A-20(b). Trajectory of drifter number 12770 deployed on December 27, 1990, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

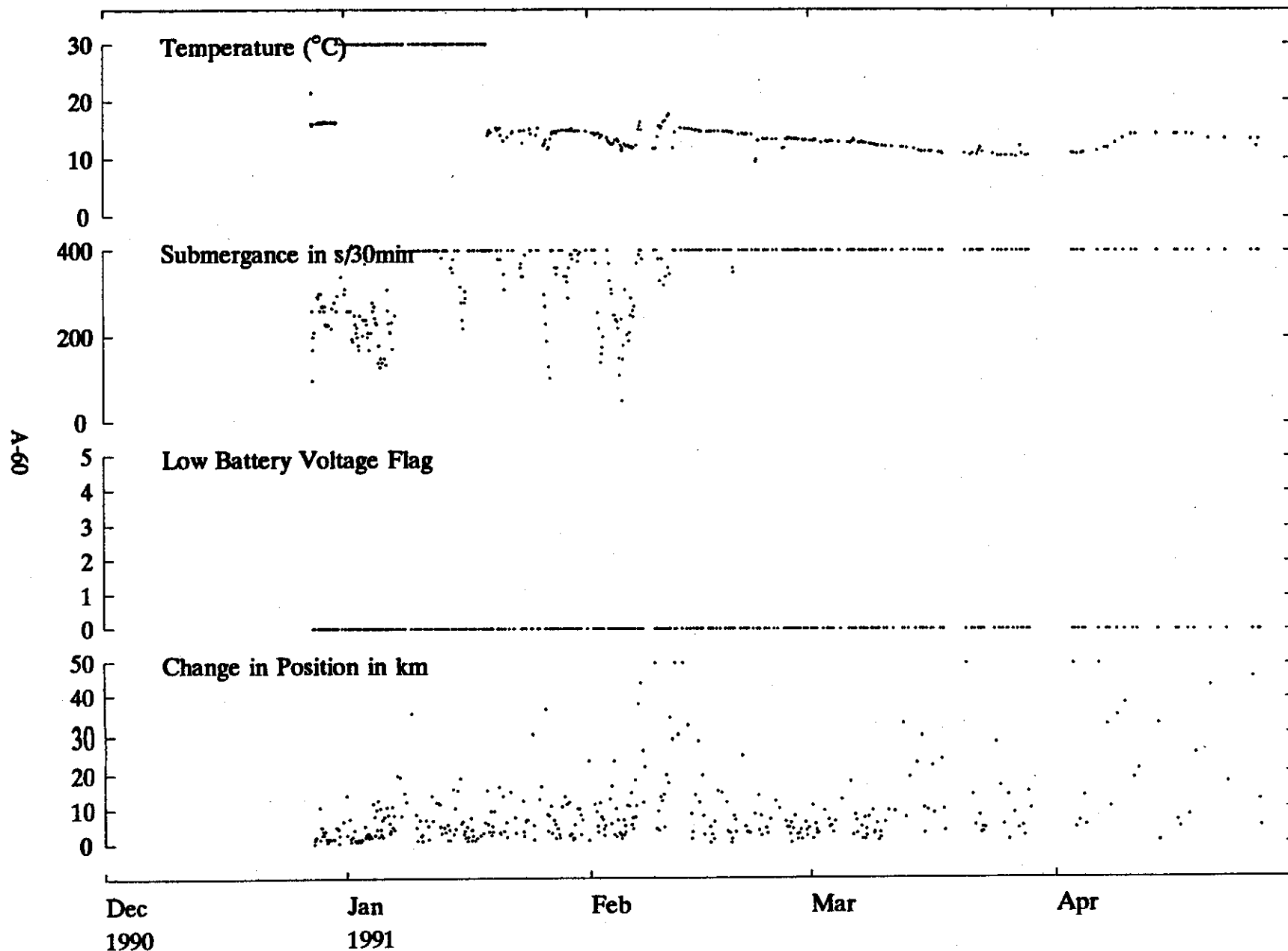


Figure A-20(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12770. The data have been quality-assured, removing transmission errors and wild points.

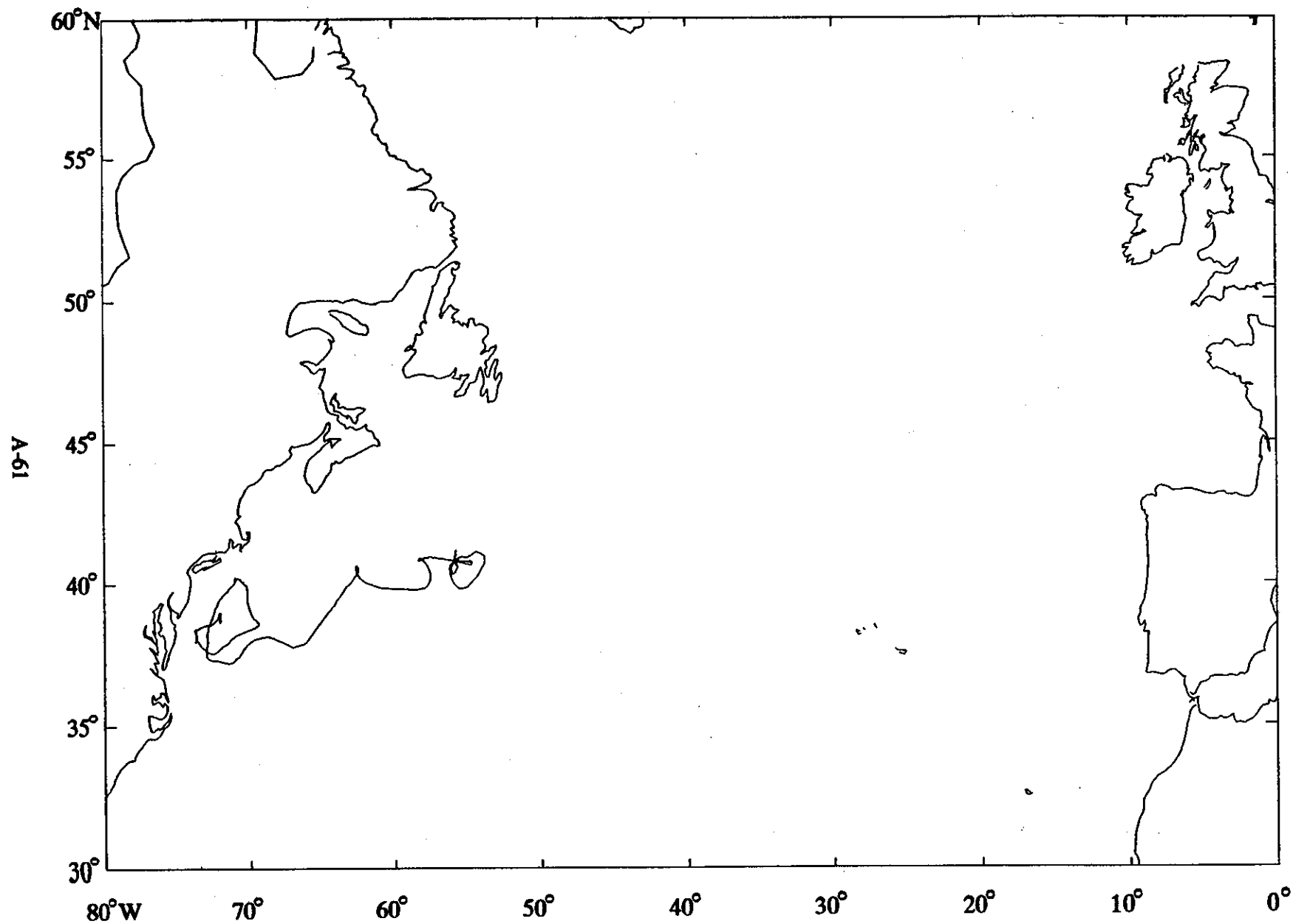


Figure A-21(a). Trajectory of drifter number 12771 deployed on February 3, 1991.
Last transmission received on June 5, 1991.

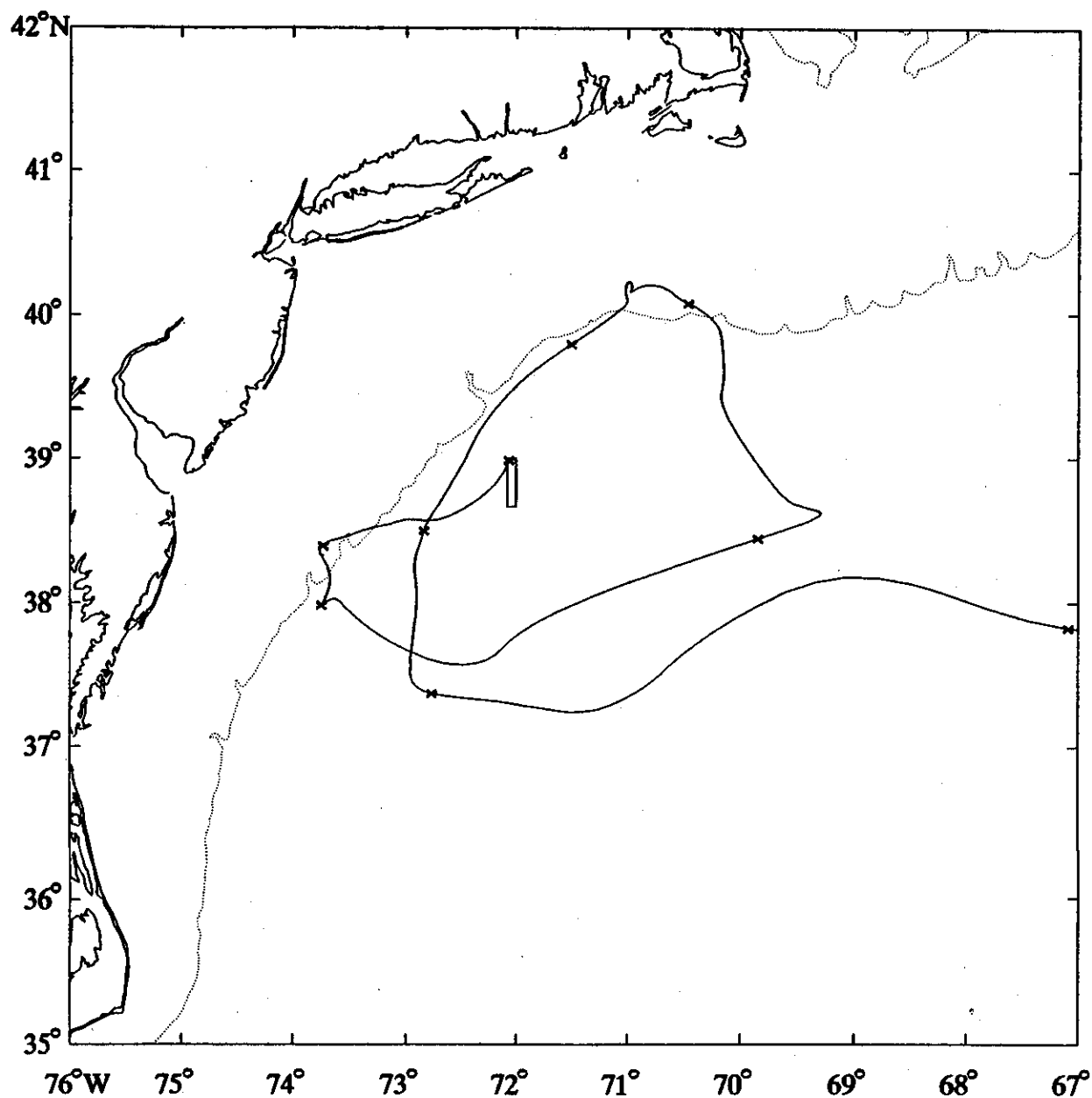


Figure A-21(b). Trajectory of drifter number 12771 deployed on February 3, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

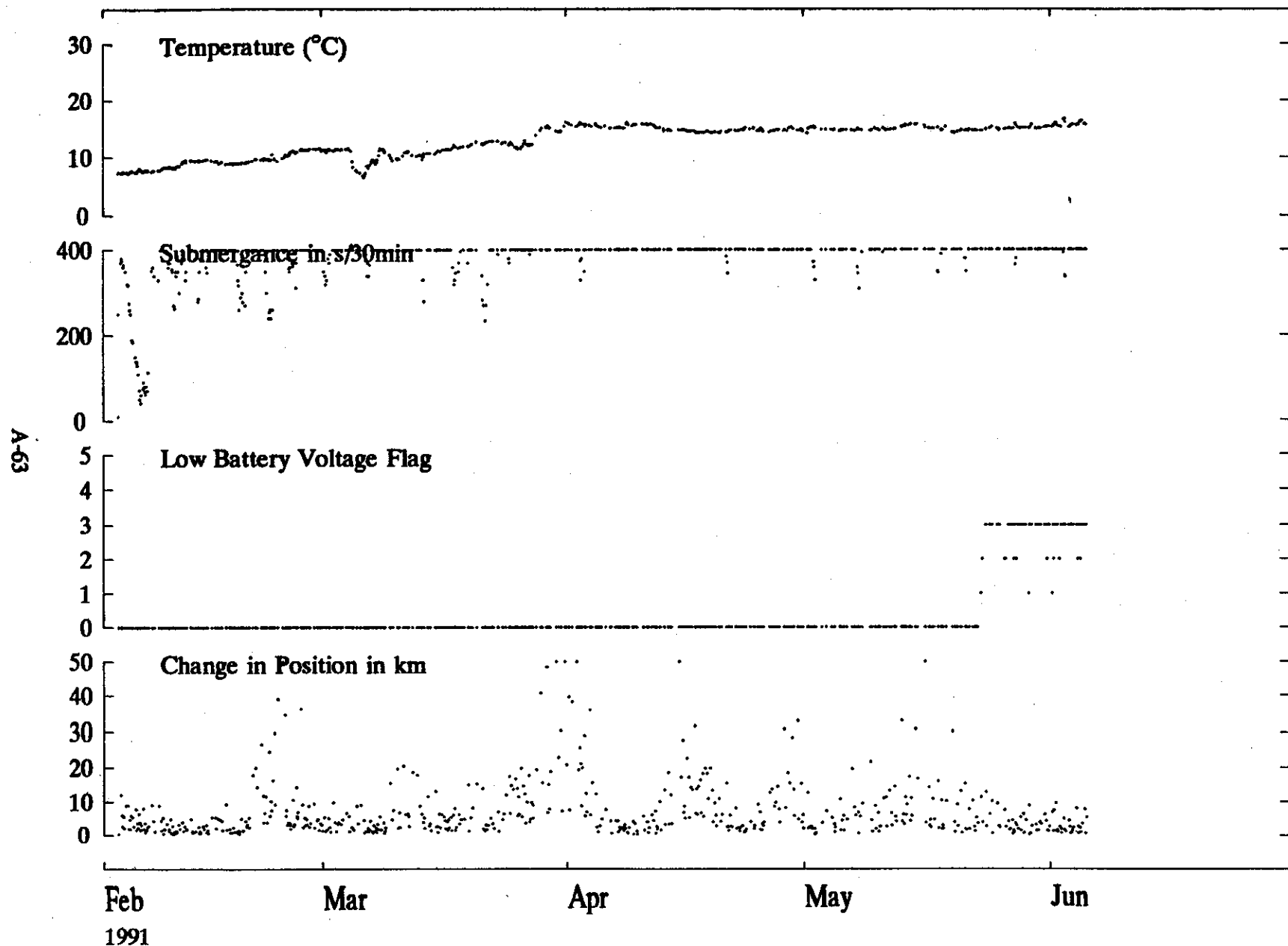
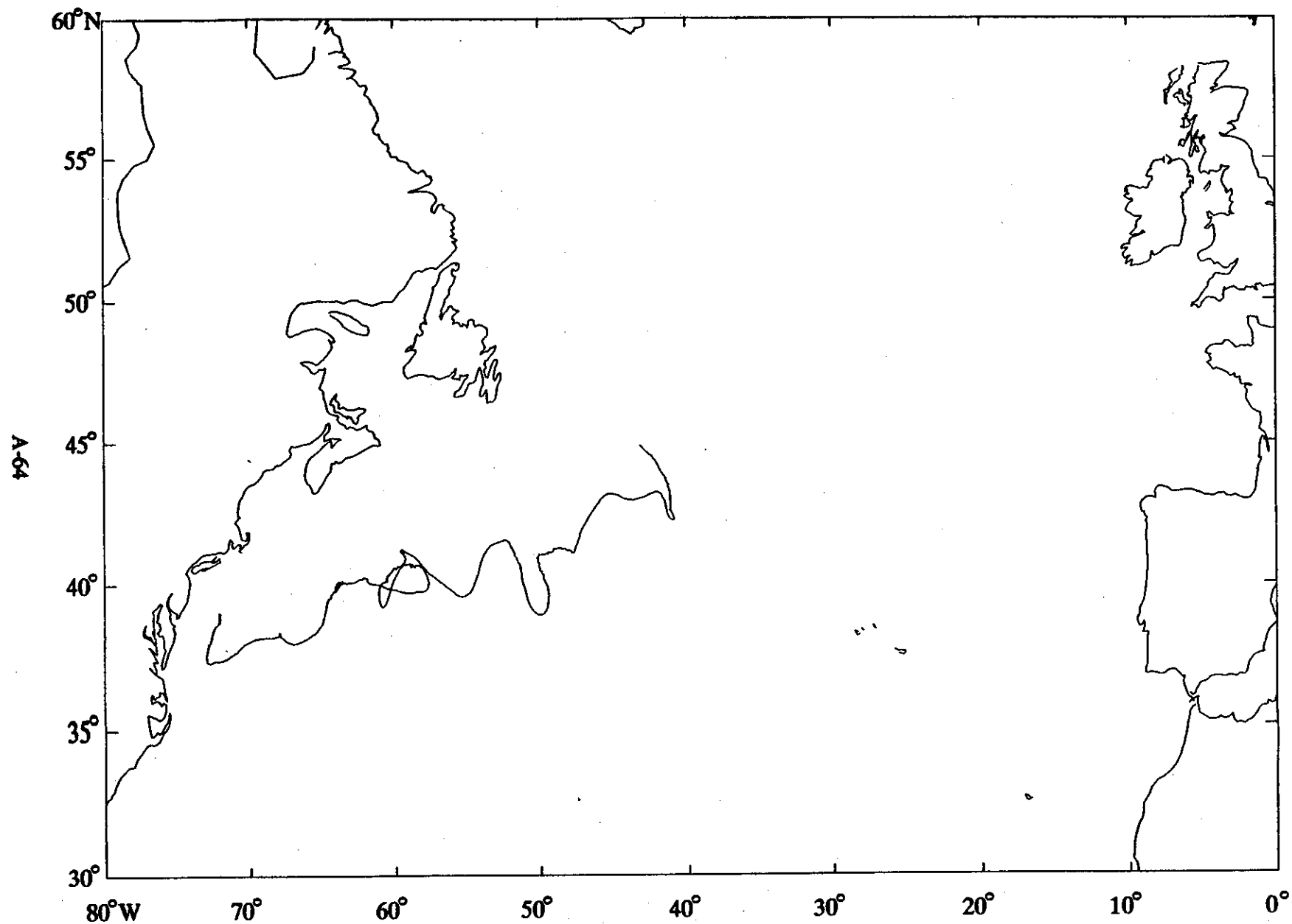


Figure A-21(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12771. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-22(a). Trajectory of drifter number 12772 deployed on March 9, 1991.
Last transmission received on July 10, 1991.**

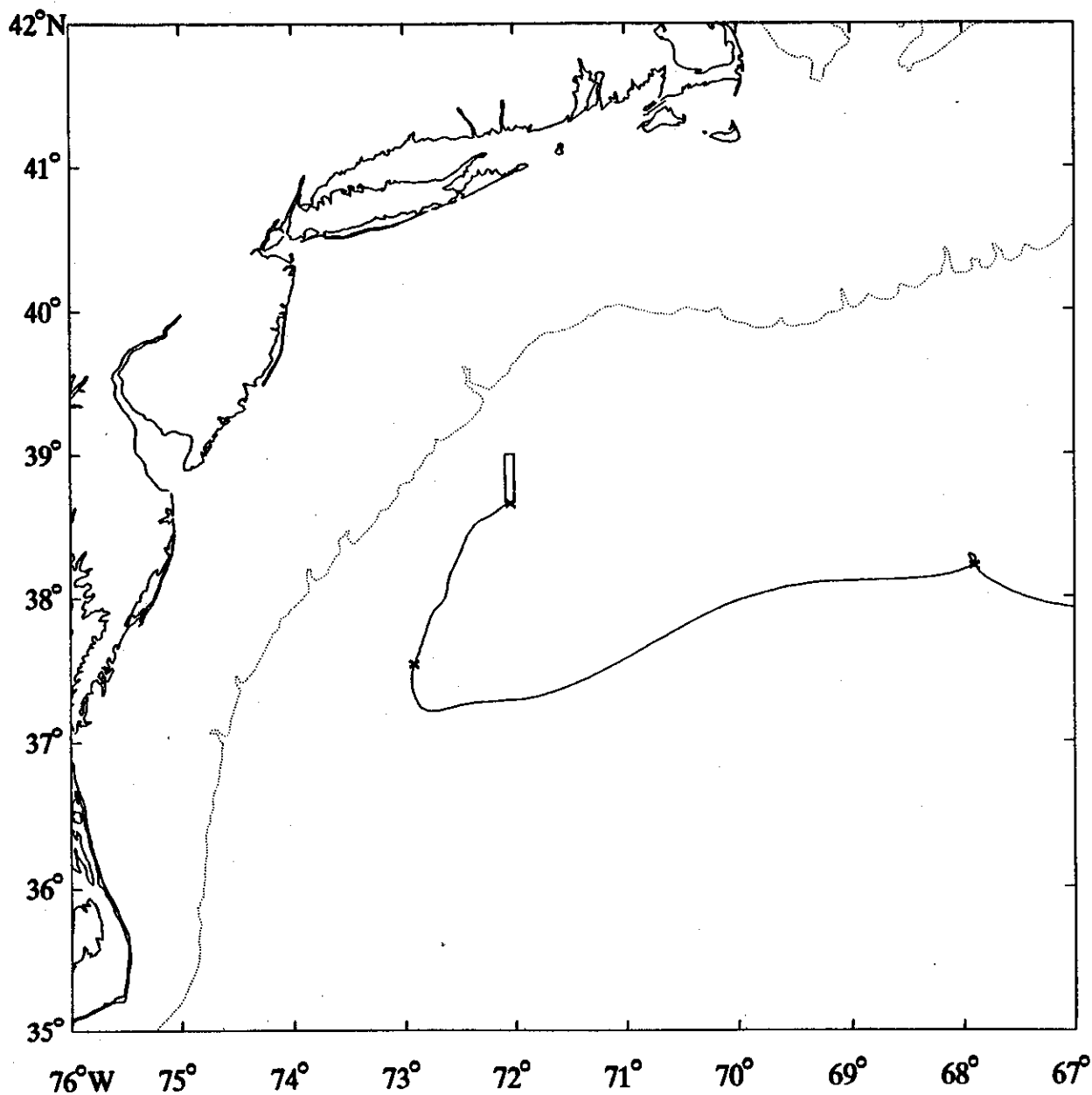


Figure A-22(b). Trajectory of drifter number 12772 deployed on March 9, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

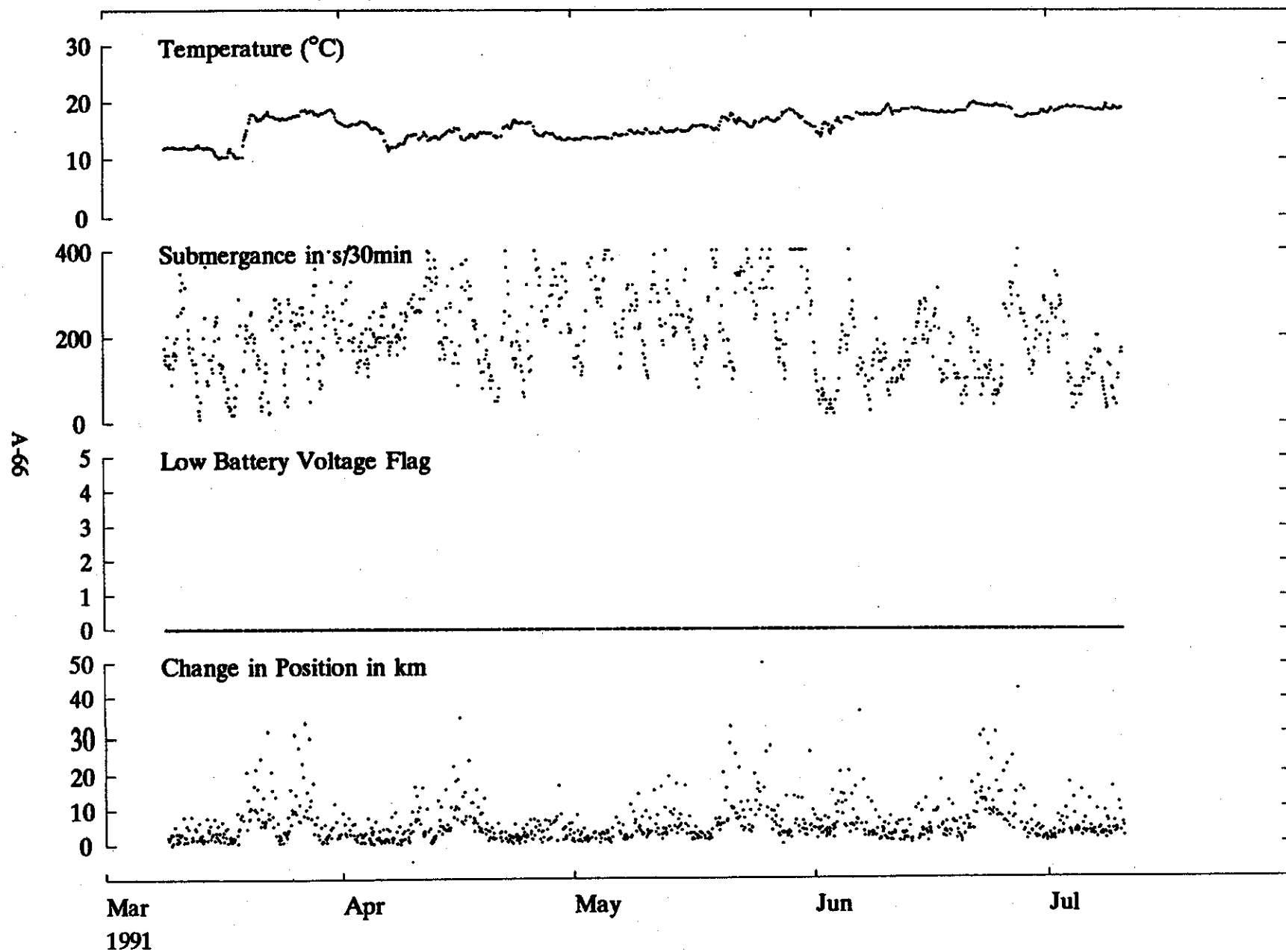
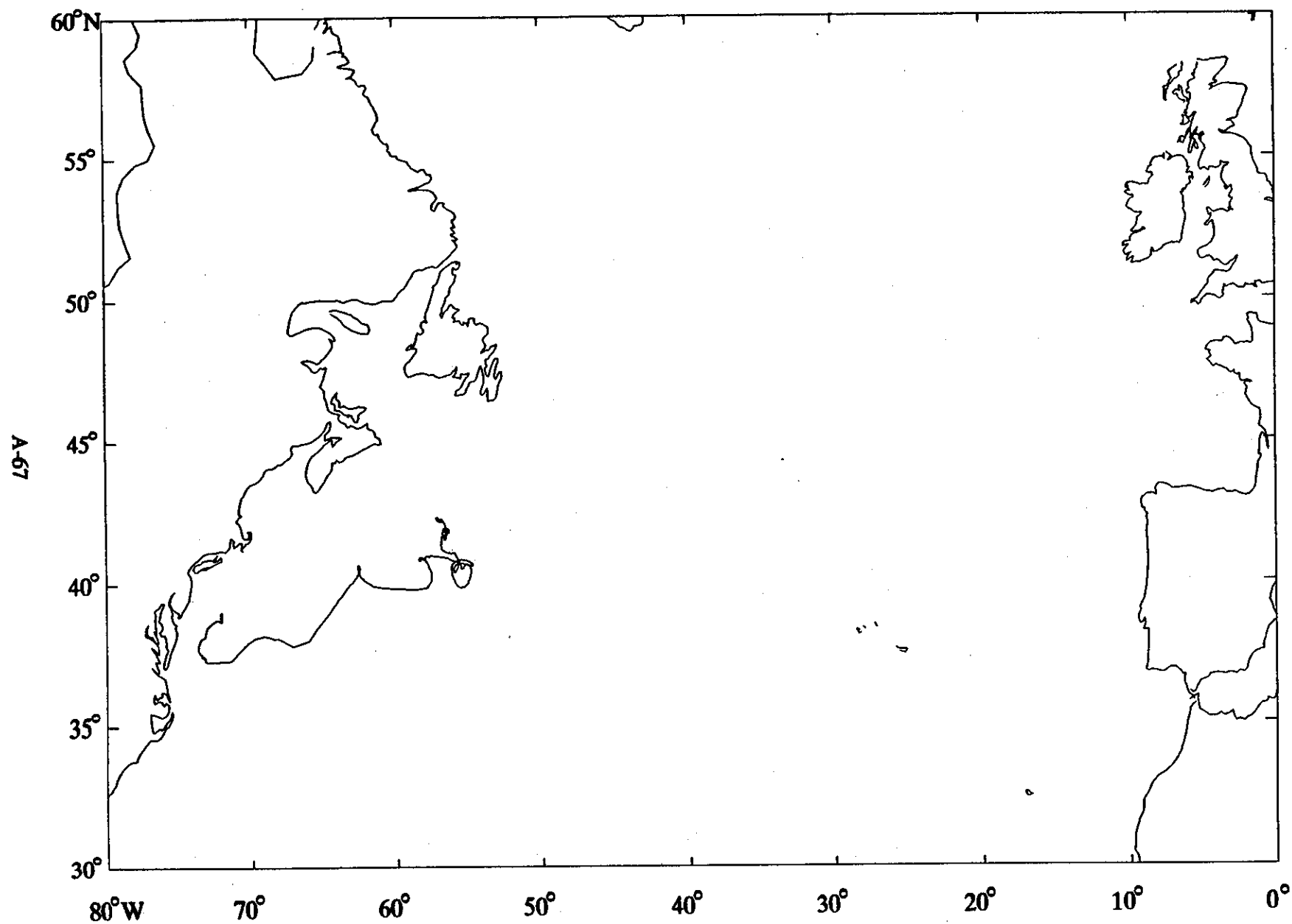


Figure A-22(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12772. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-23(a). Trajectory of drifter number 12773 deployed on March 7, 1991.
Last transmission received on July 8, 1991.**

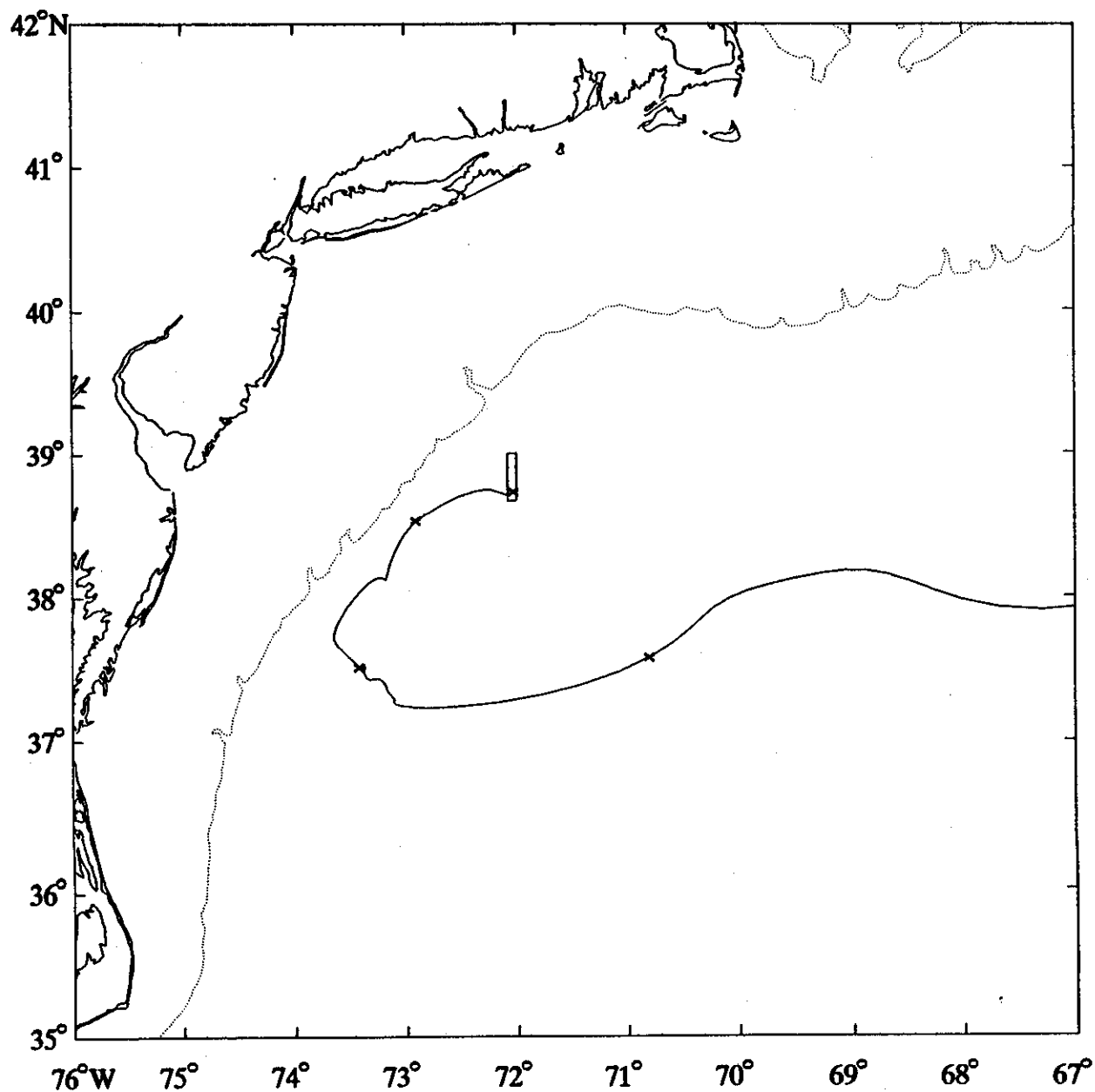


Figure A-23(b). Trajectory of drifter number 12773 deployed on March 7, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

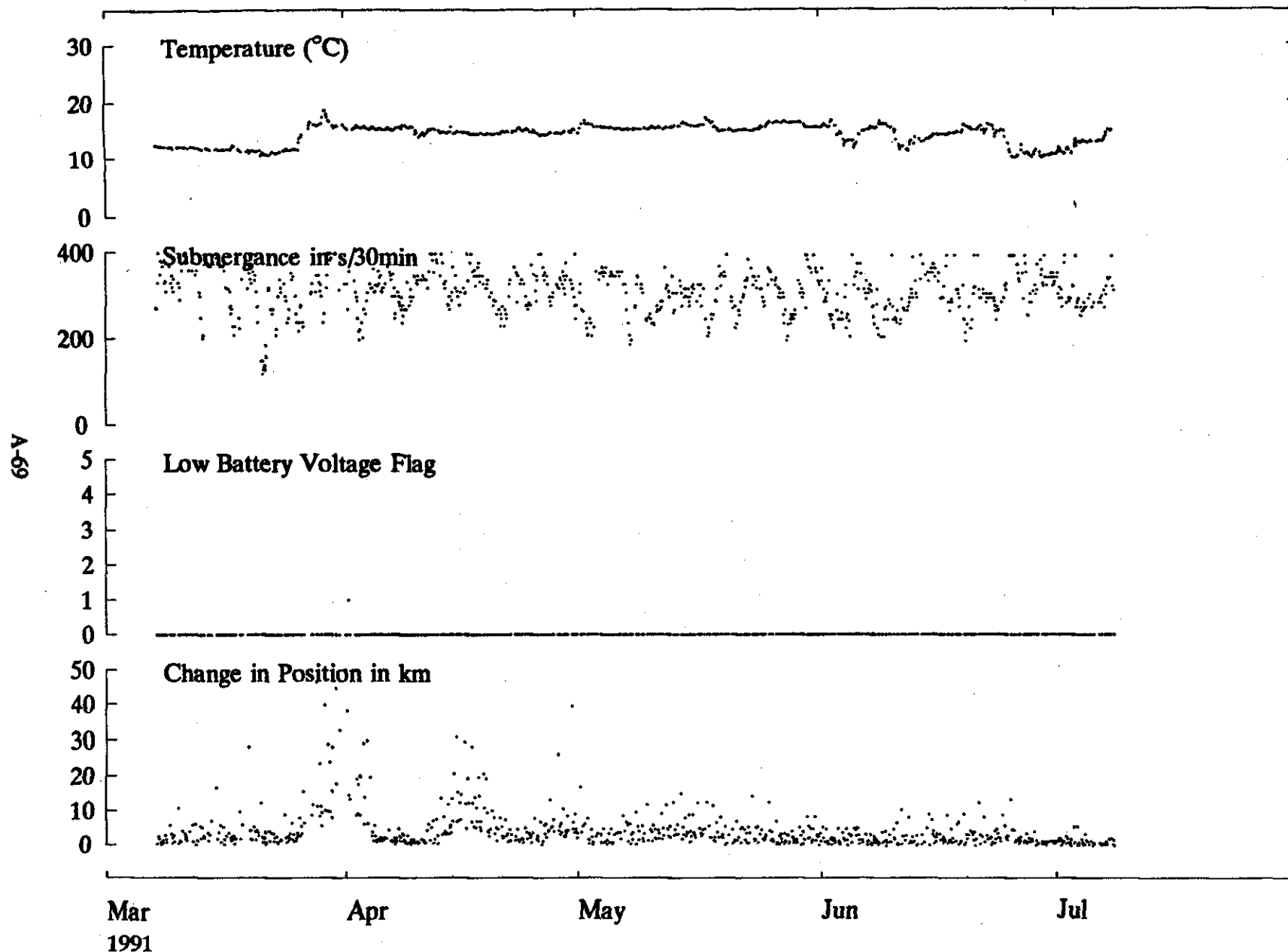


Figure A-23(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12773. The data have been quality-assured, removing transmission errors and wild points.

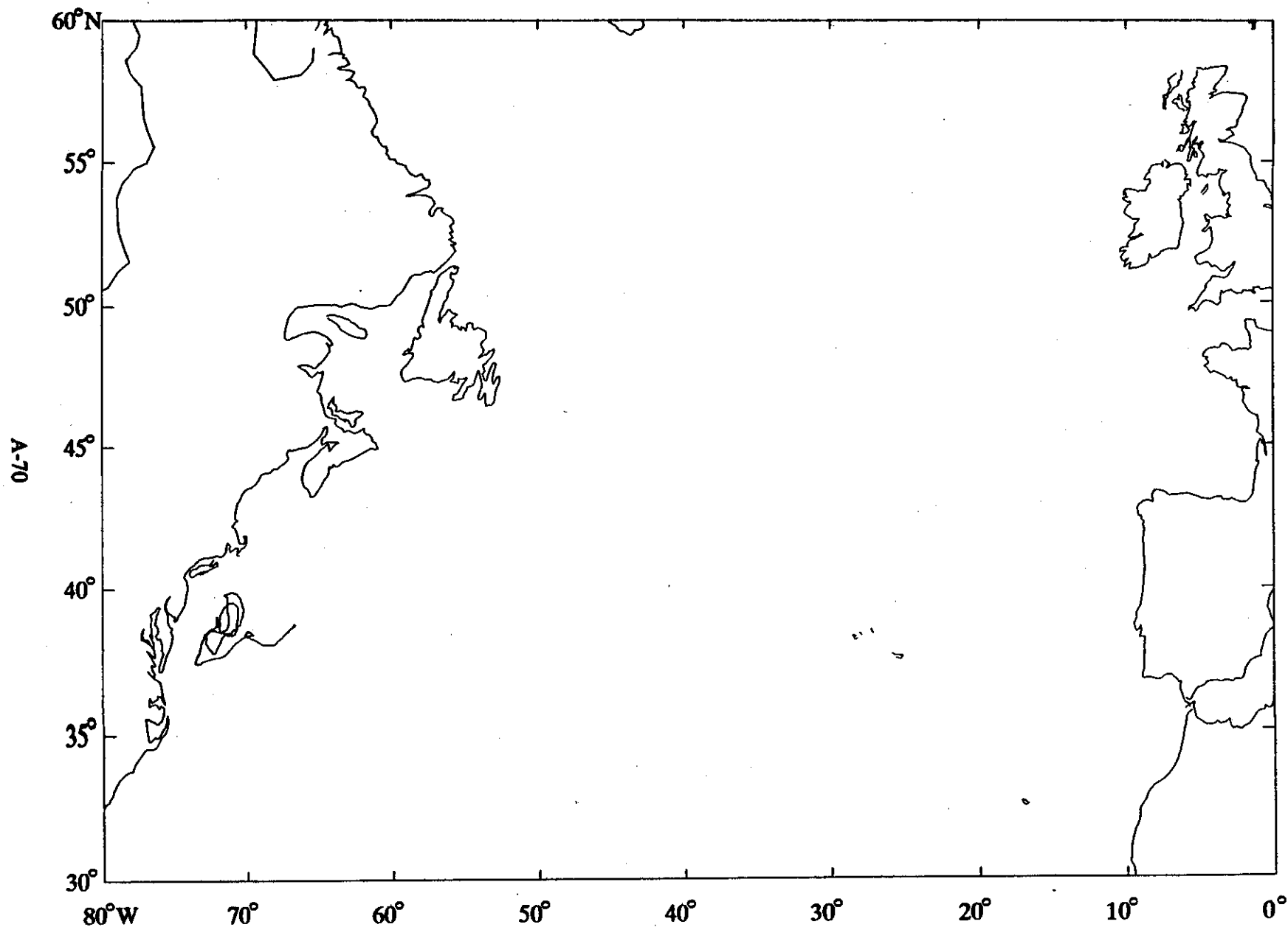


Figure A-24(a). Trajectory of drifter number 12774 deployed on February 18, 1991.
Last transmission received on May 30, 1991.

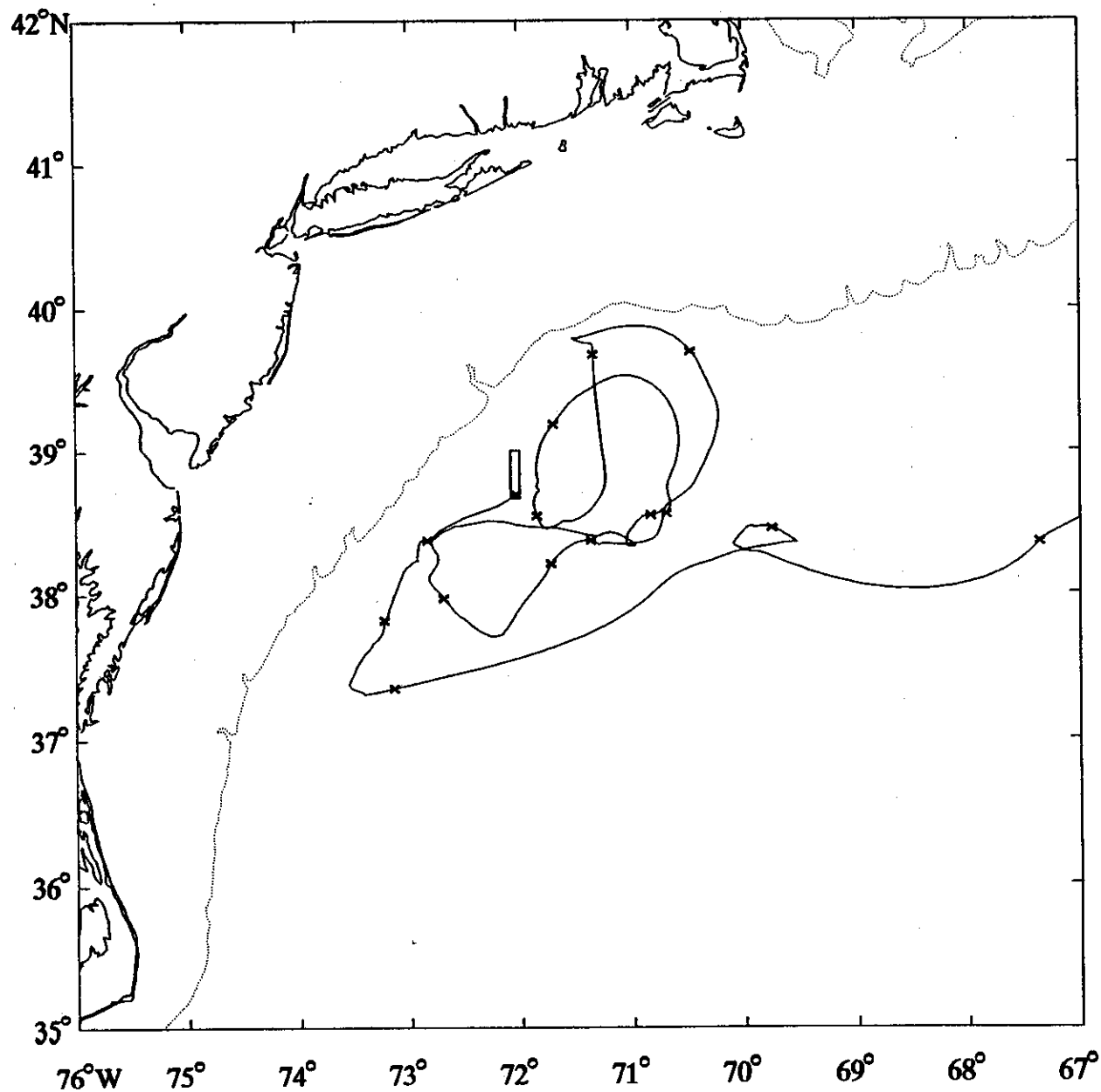


Figure A-24(b). Trajectory of drifter number 12774 deployed on February 18, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

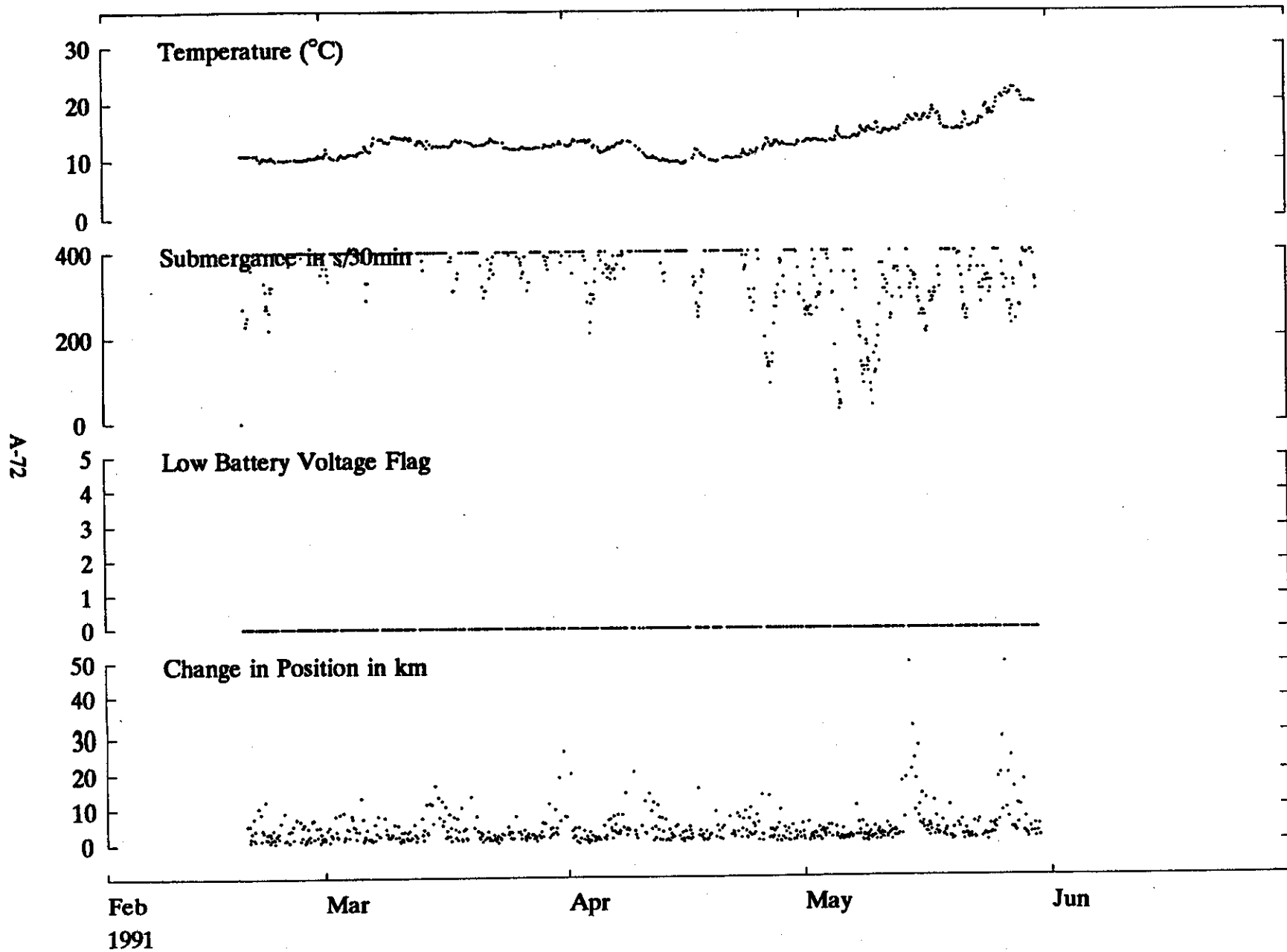
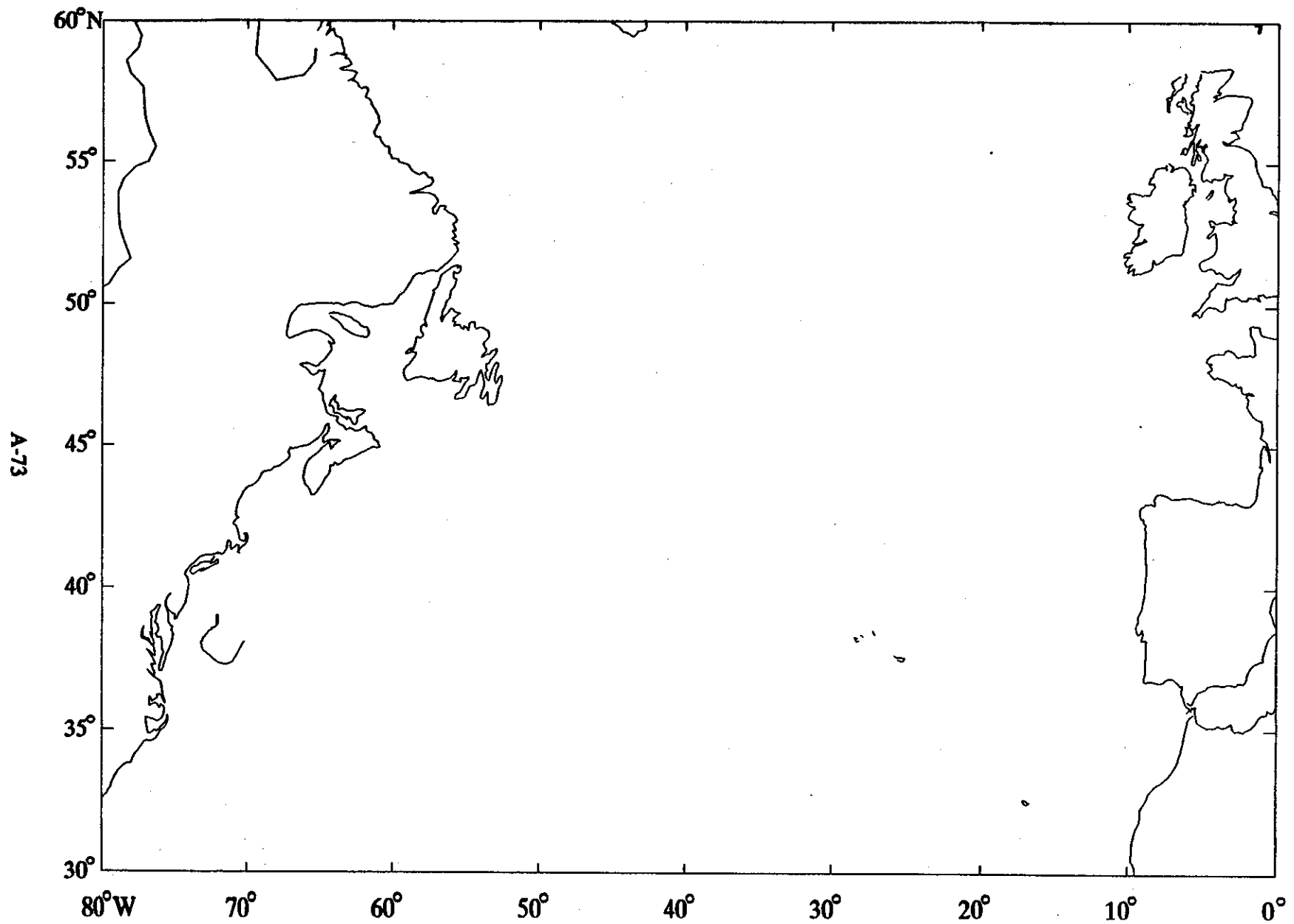


Figure A-24(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12774. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-25(a). Trajectory of drifter number 12775 deployed on February 27, 1991.
Last transmission received on March 13, 1991.**

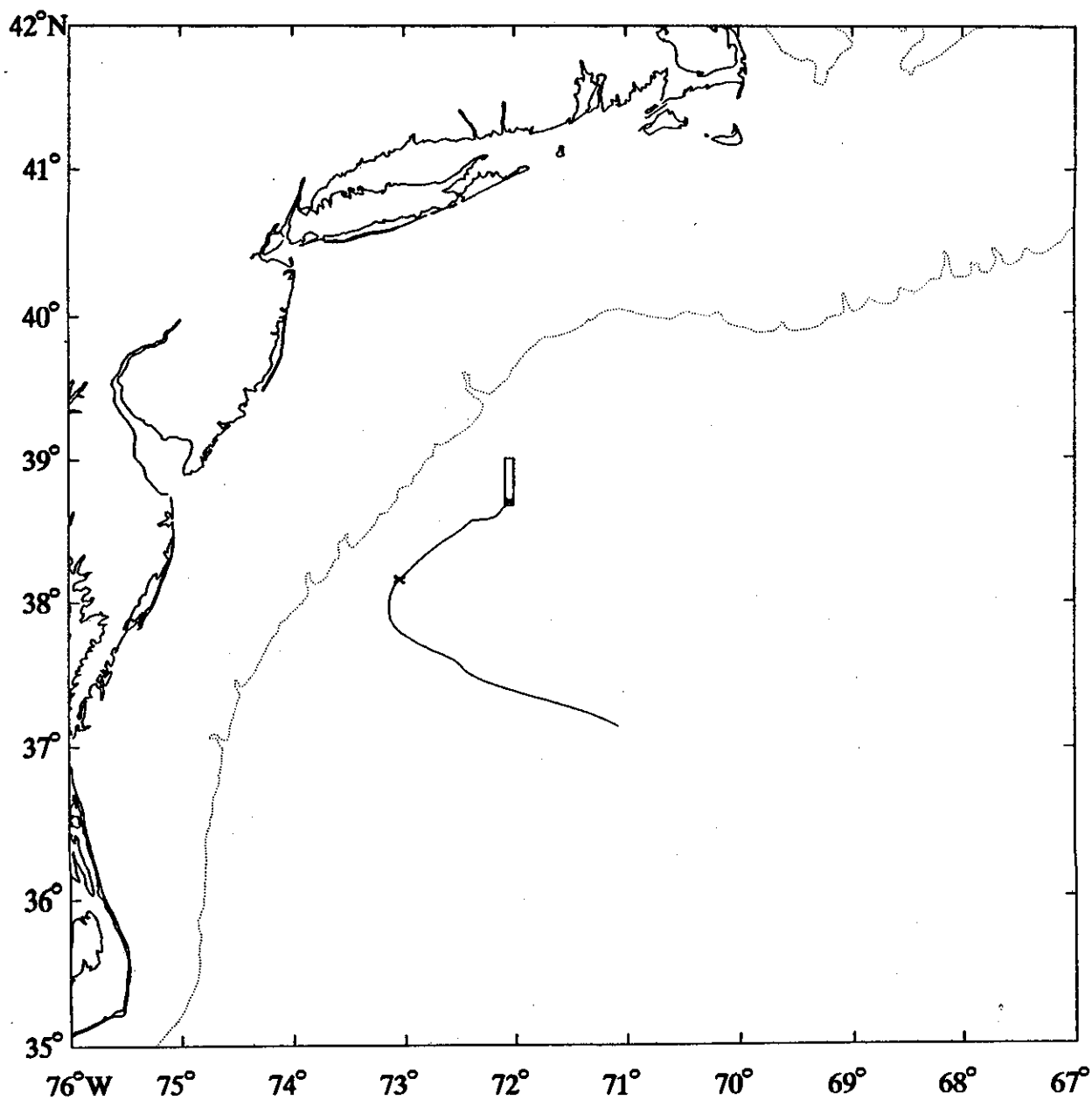


Figure A-25(b). Trajectory of drifter number 12775 deployed on February 27, 1991, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

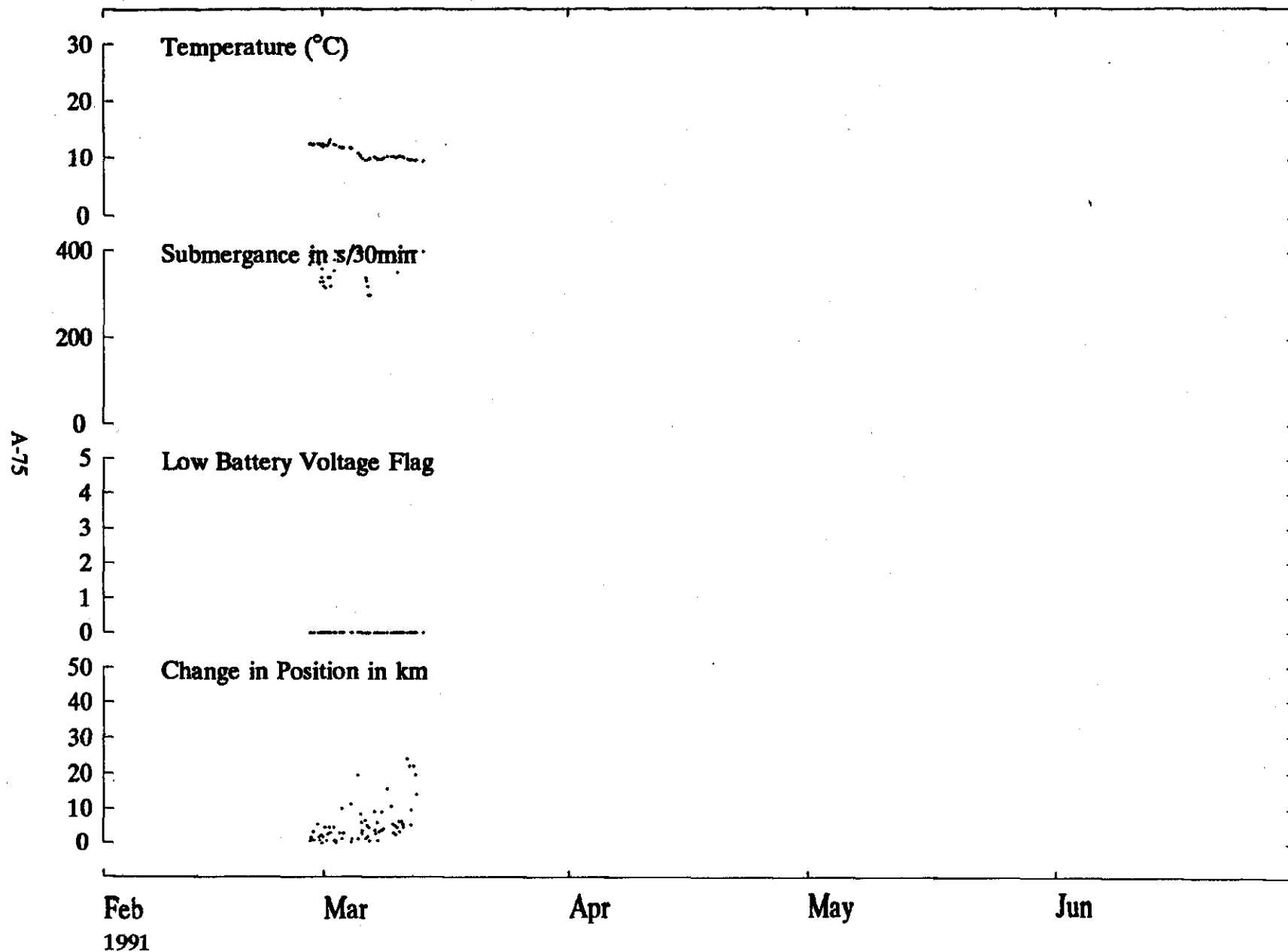
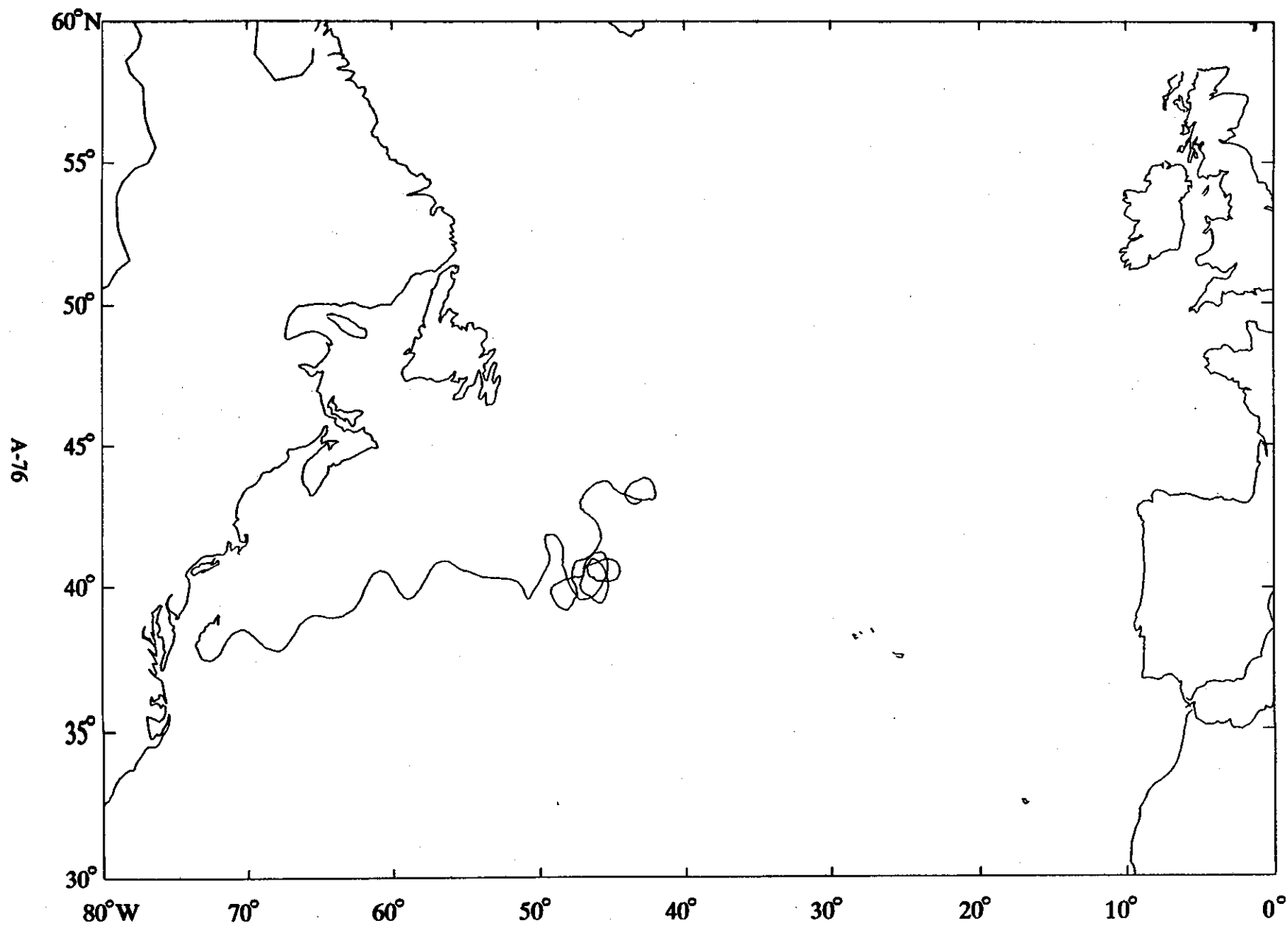


Figure A-25(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12775. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-26(a). Trajectory of drifter number 12776 deployed on January 27, 1991.
Last transmission received on May 30, 1991.**

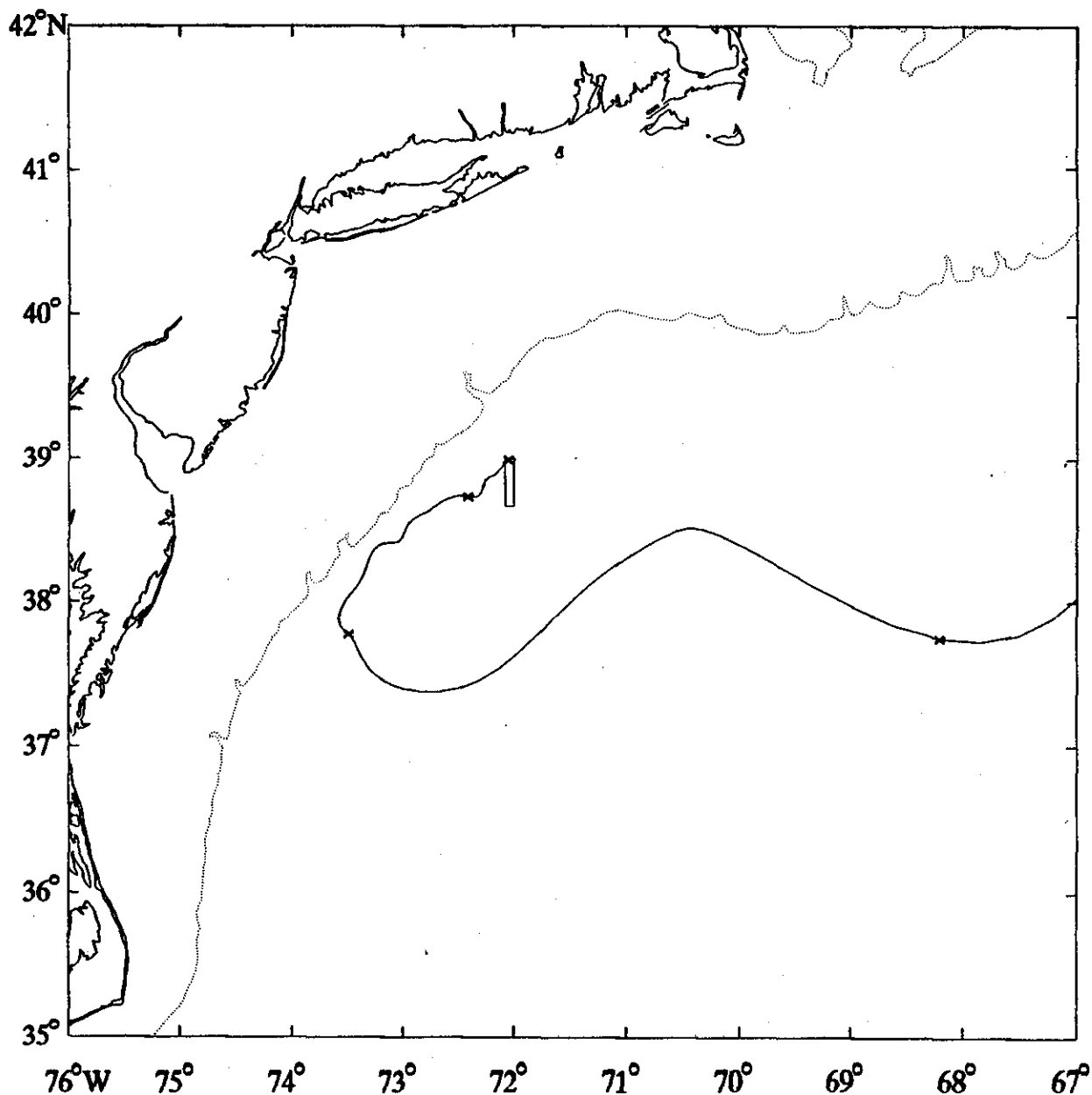


Figure A-26(b). Trajectory of drifter number 12776 deployed on January 27, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

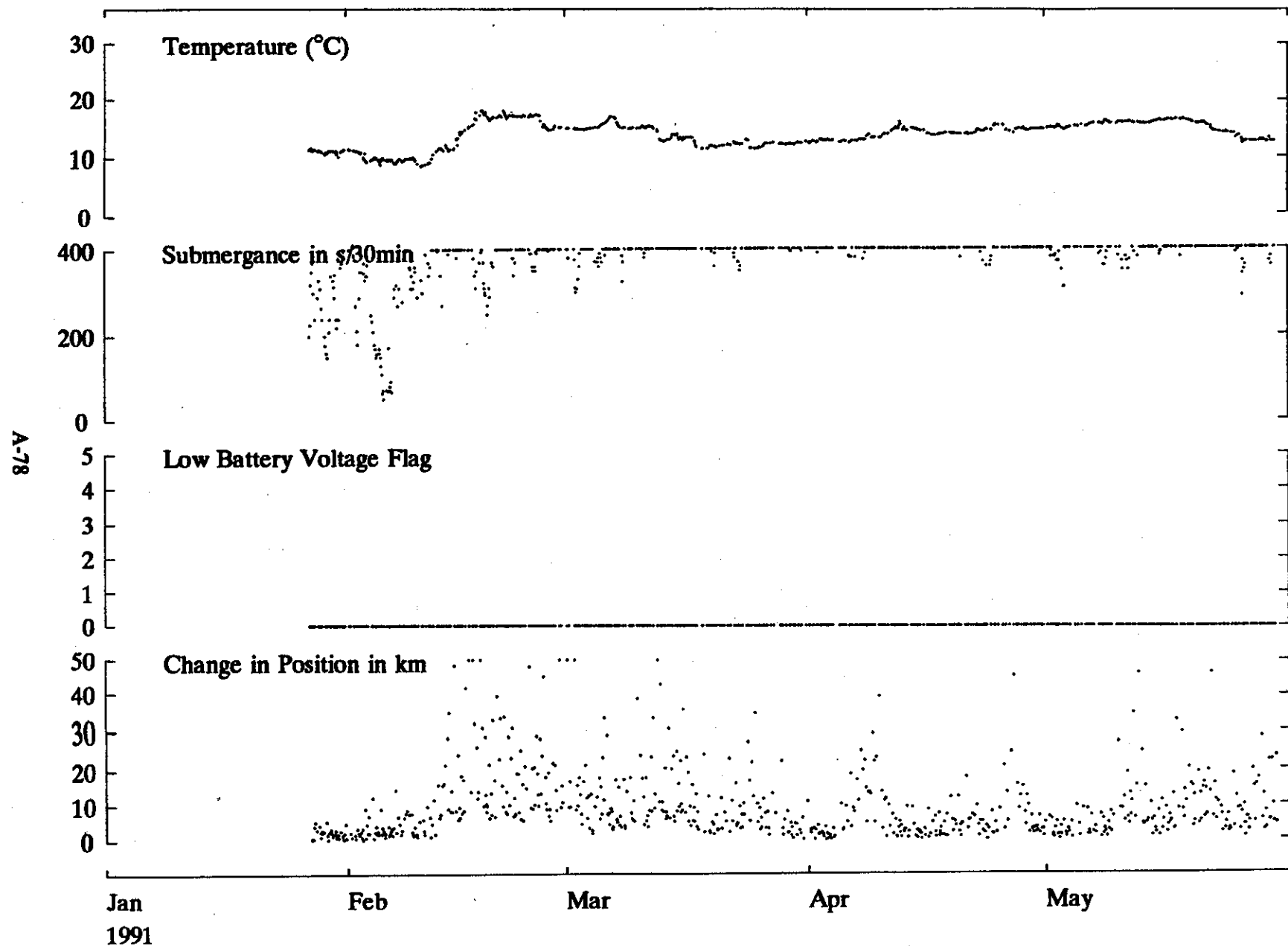
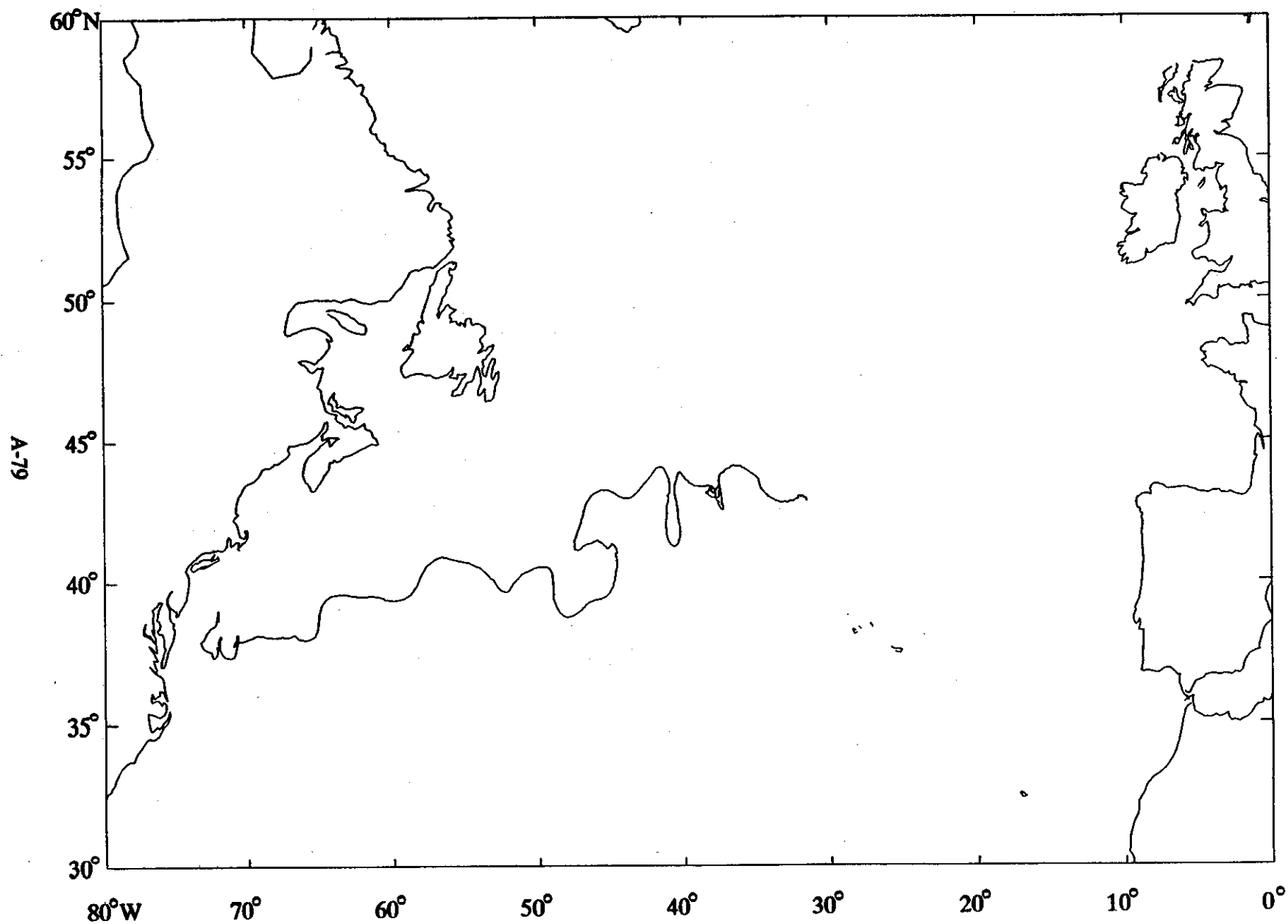


Figure A-26(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12776. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-27(a). Trajectory of drifter number 12777 deployed on February 21, 1991.
Last transmission received on June 24, 1991.**

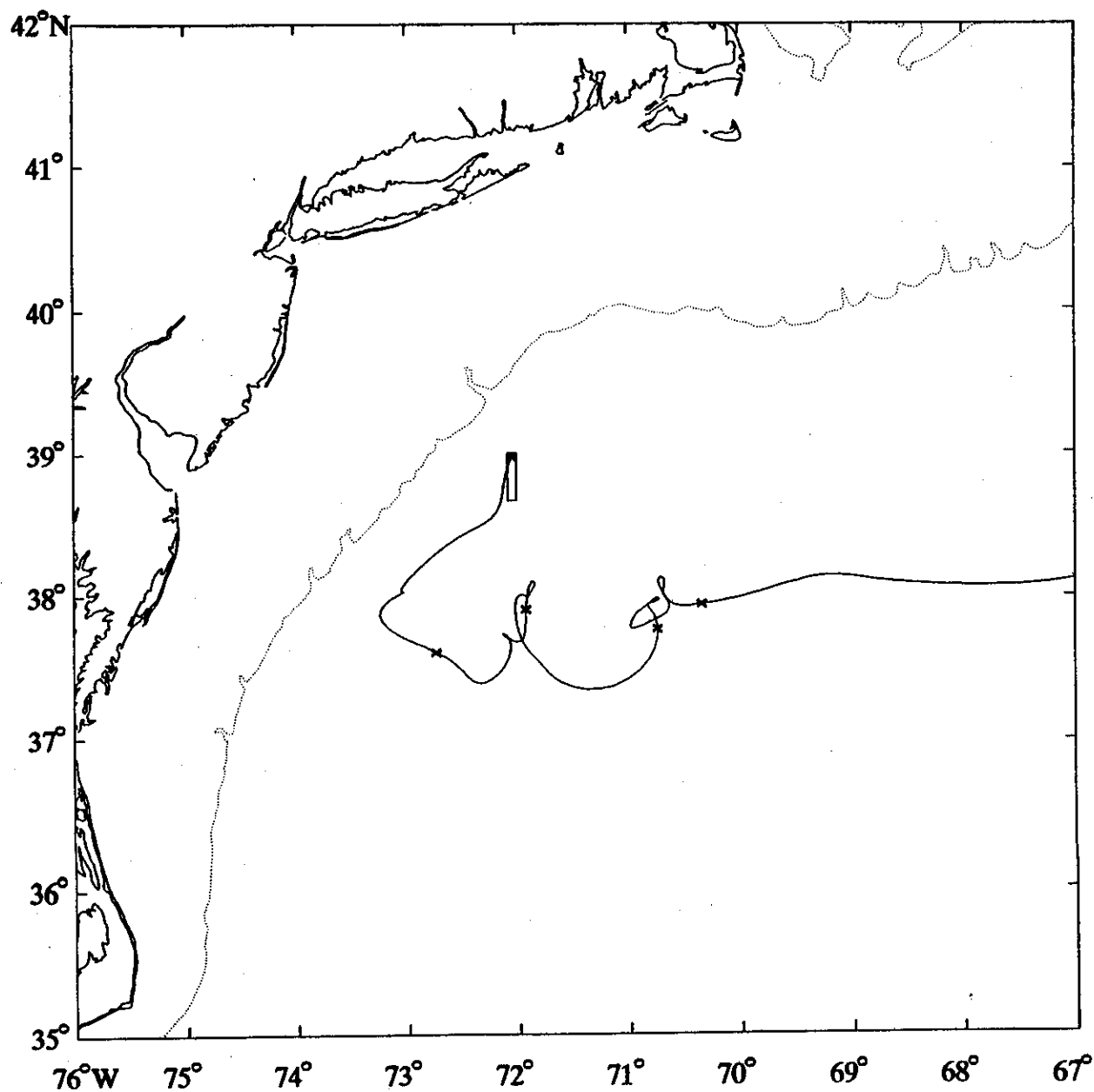


Figure A-27(b). Trajectory of drifter number 12777 deployed on February 21, 1991, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure. Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

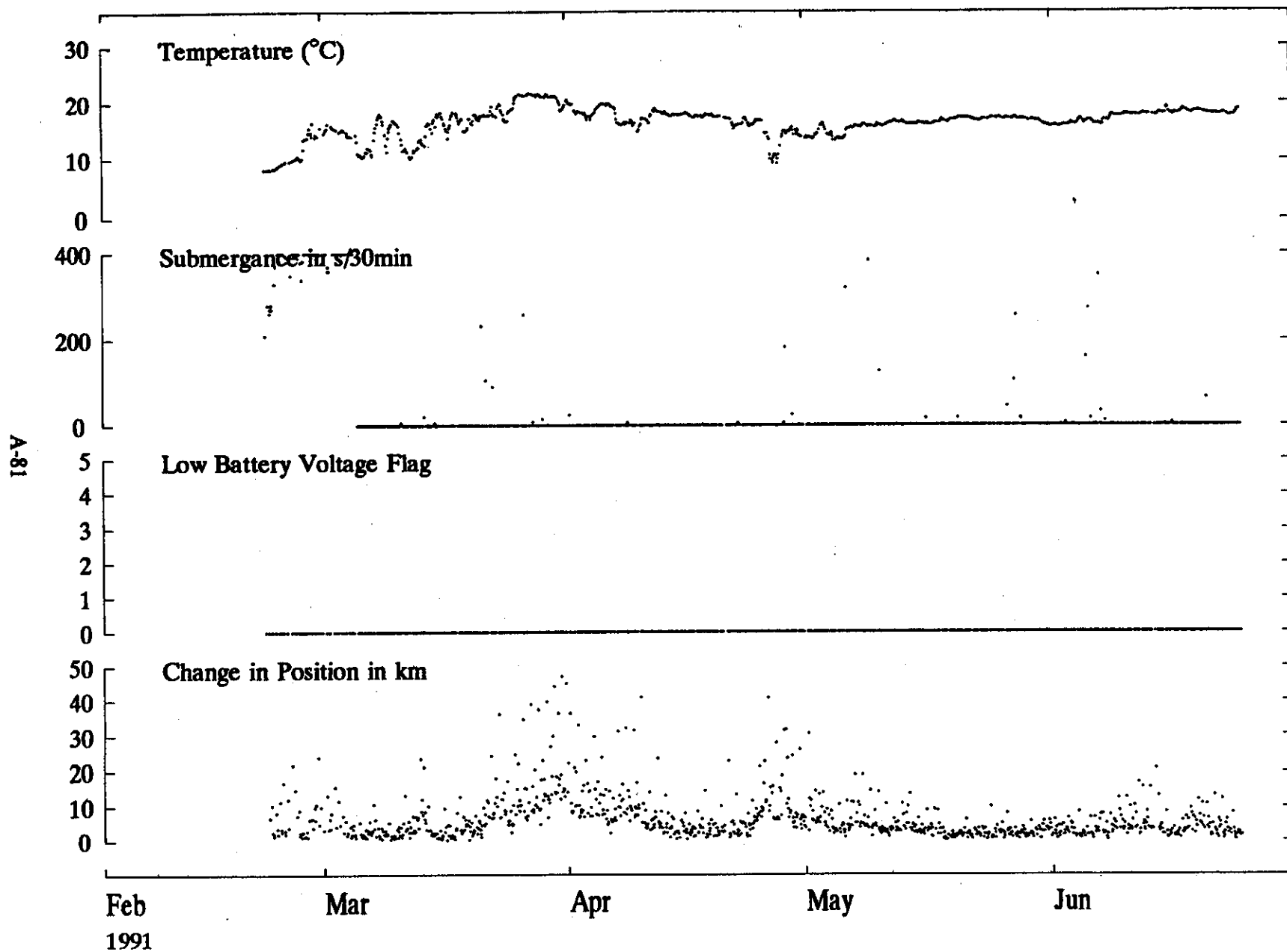
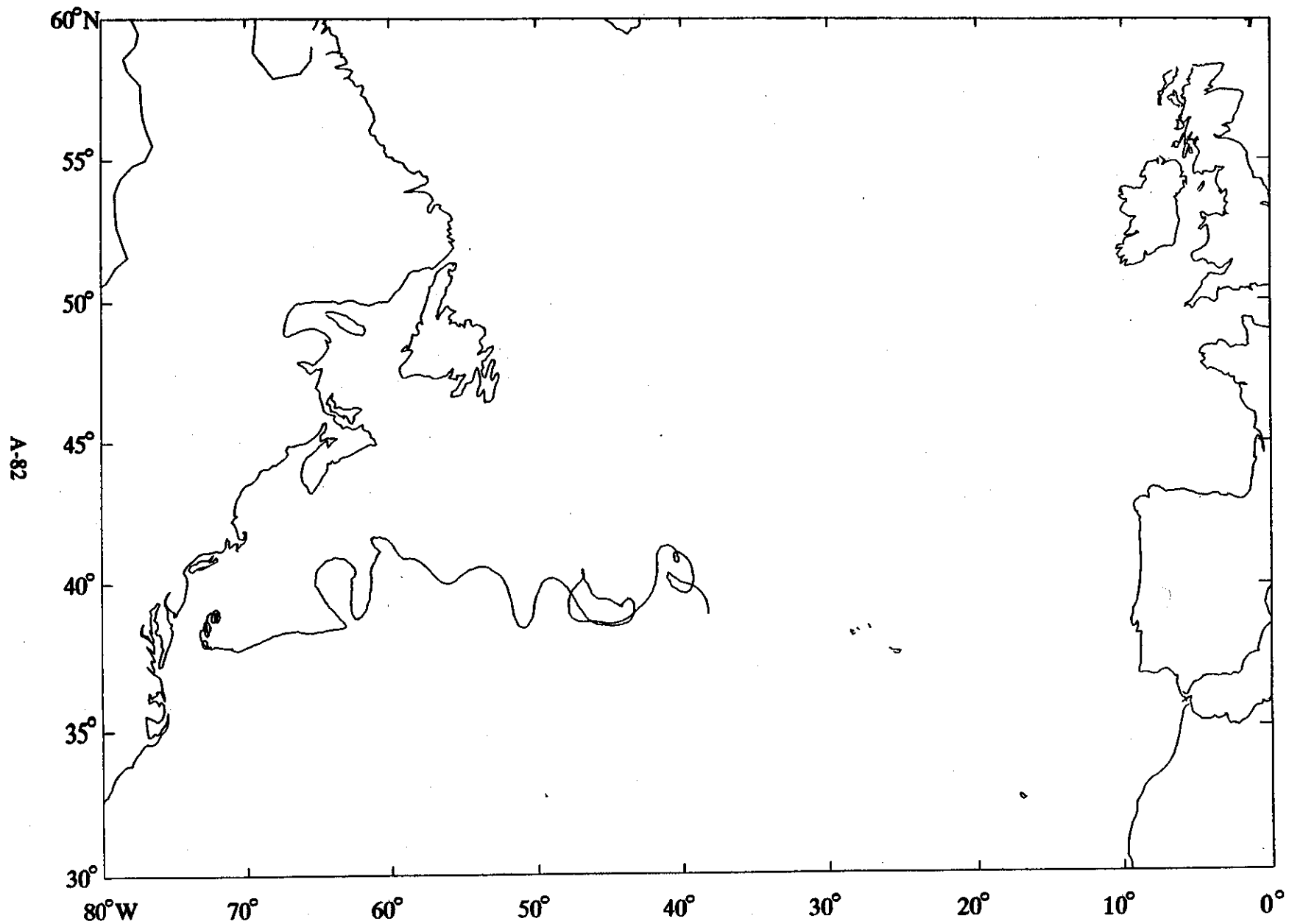


Figure A-27(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12777. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-28(a). Trajectory of drifter number 12730A deployed on April 4, 1991.
Last transmission received on August 7, 1991.**

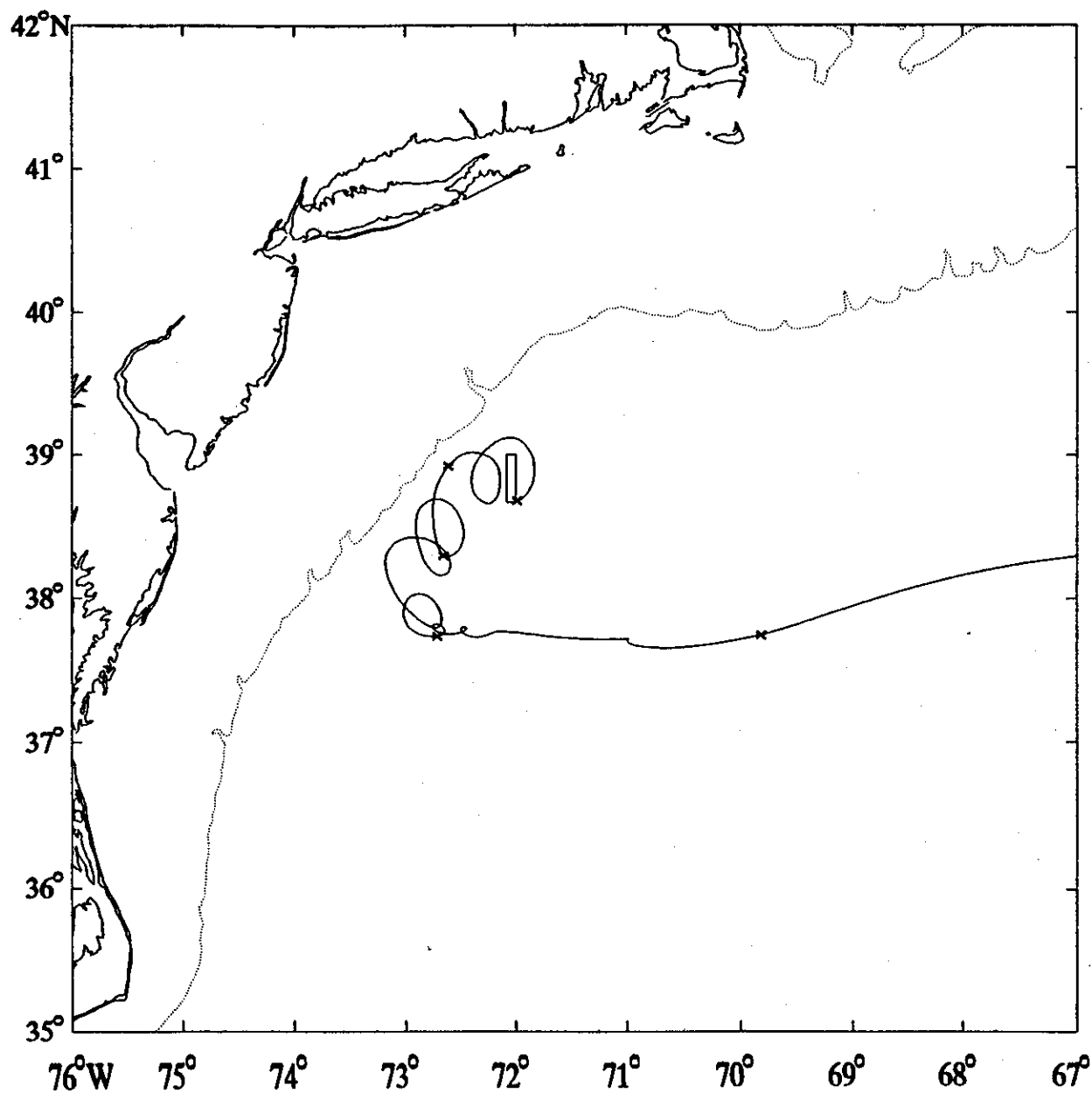


Figure A-28(b). Trajectory of drifter number 12730A deployed on April 4, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

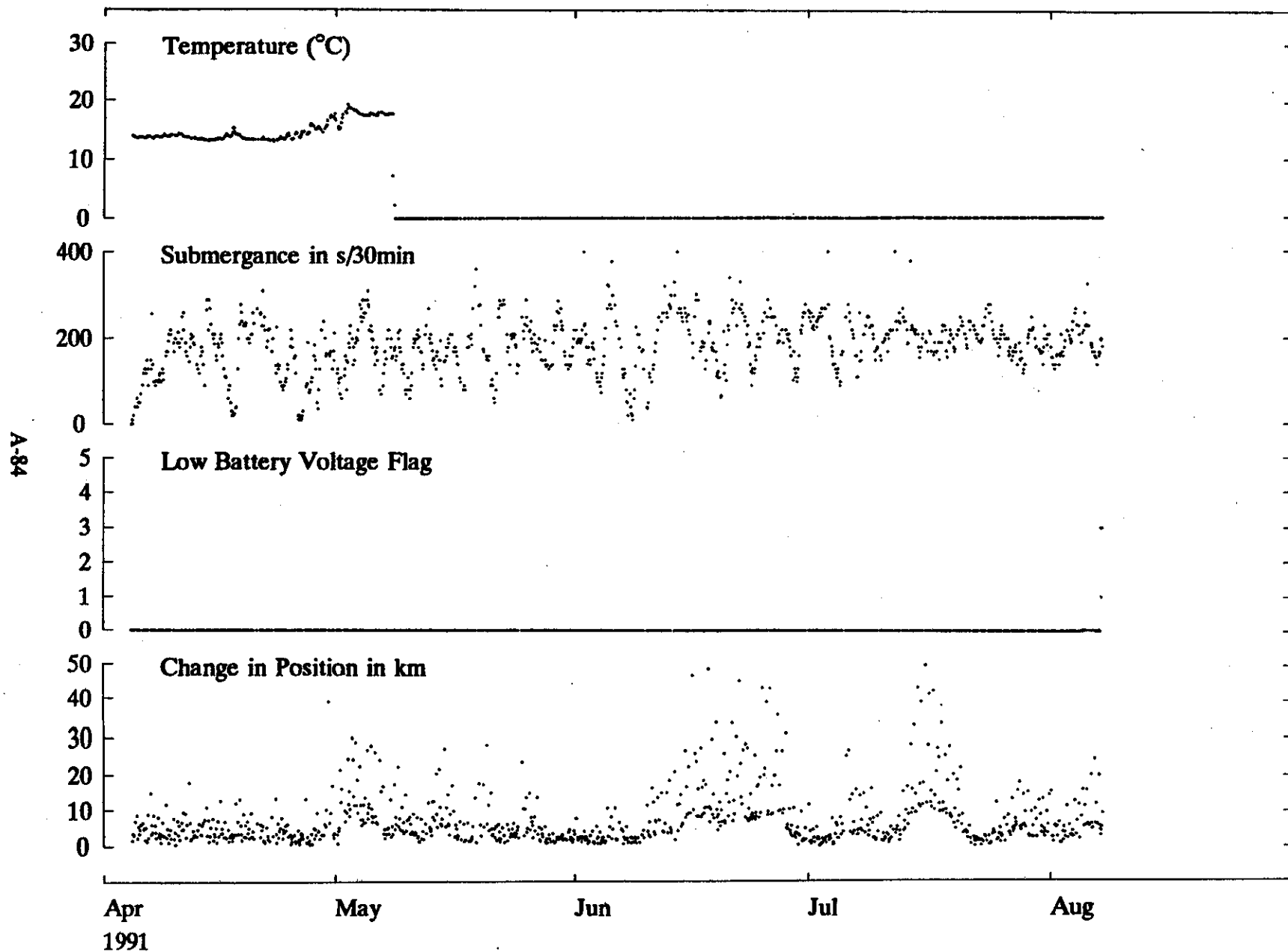
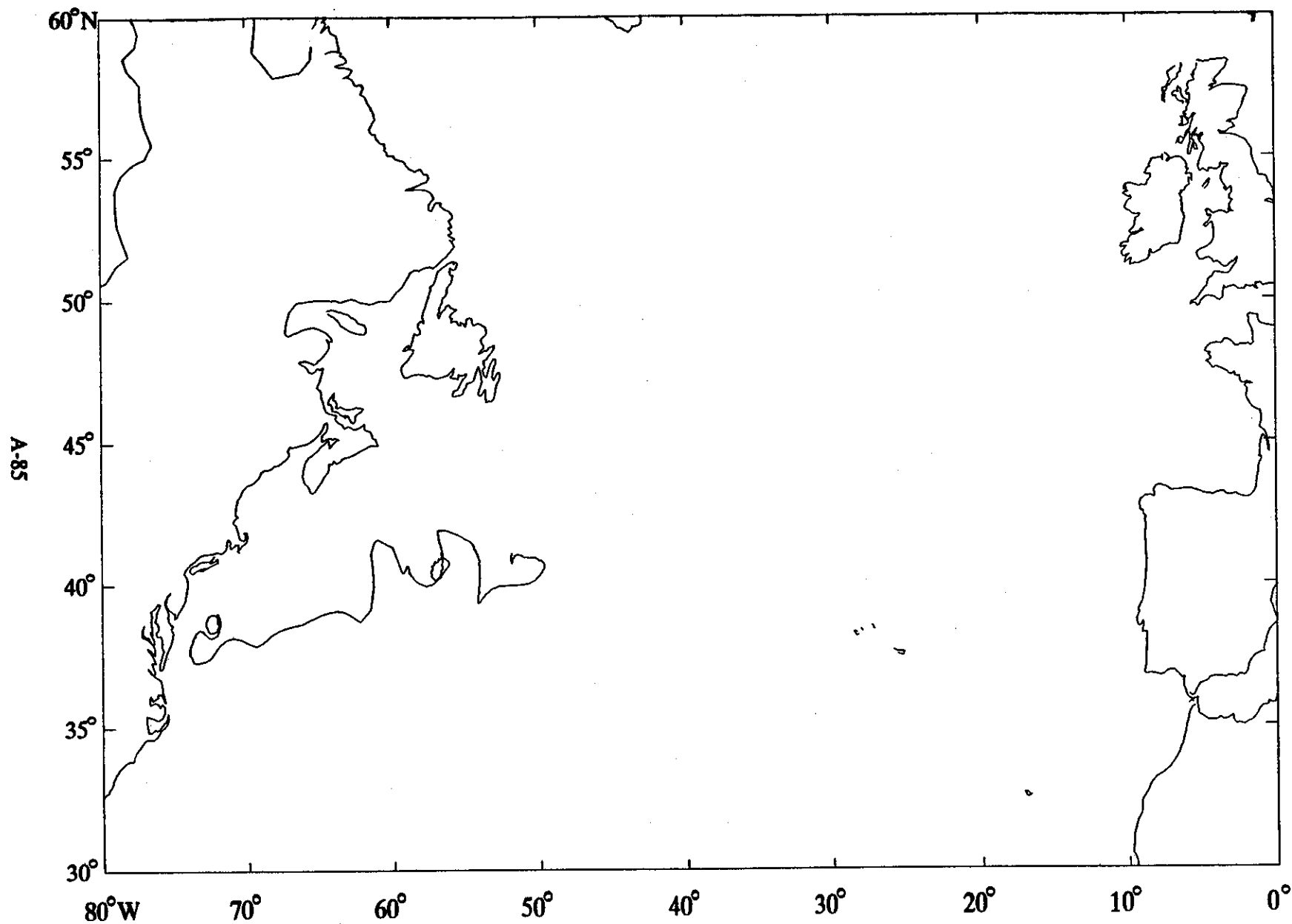


Figure A-28(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12730A. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-29(a). Trajectory of drifter number 12731A deployed on May 16, 1991.
Last transmission received on August 12, 1991.**

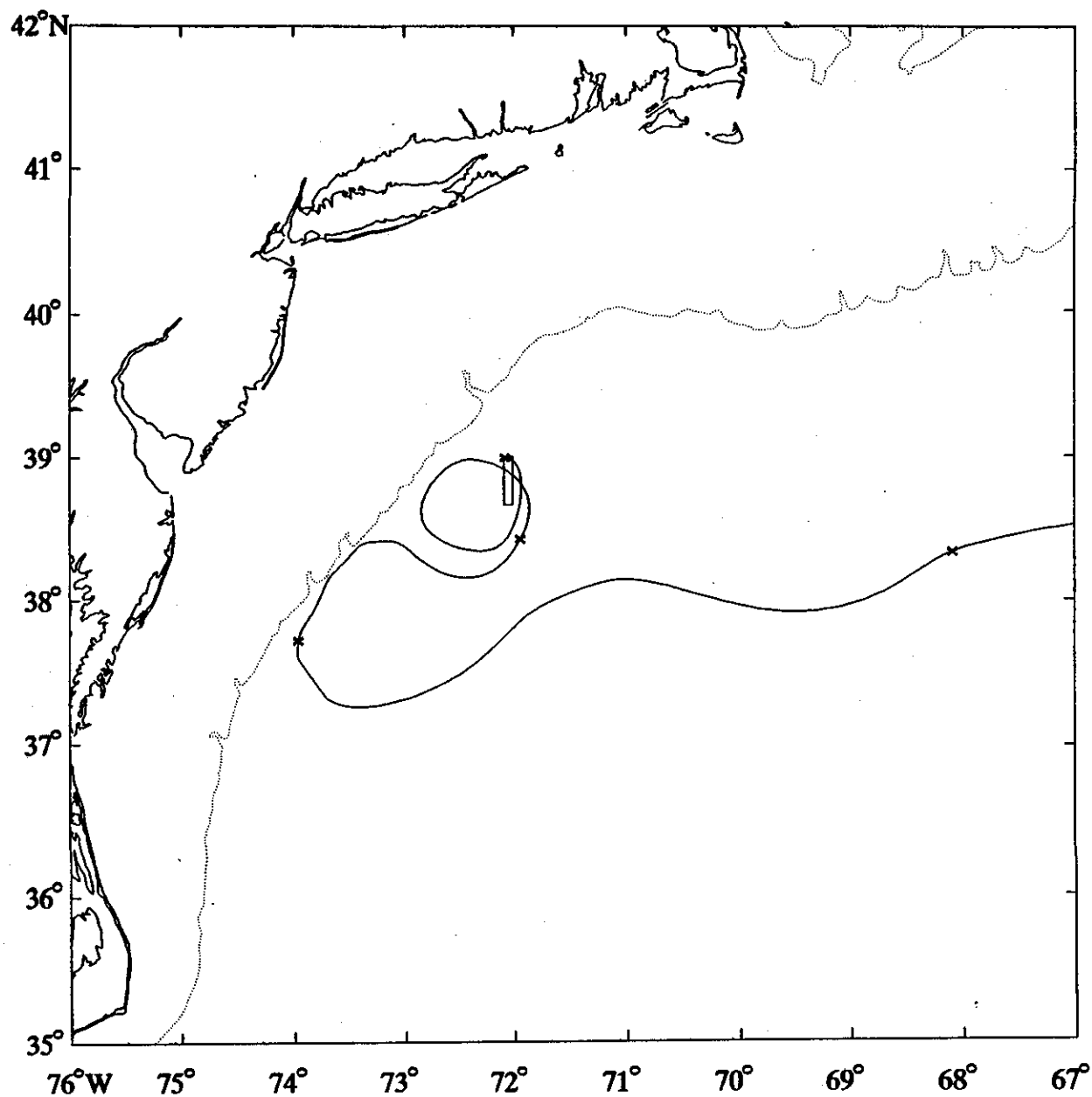


Figure A-29(b). Trajectory of drifter number 12731A deployed on May 16, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

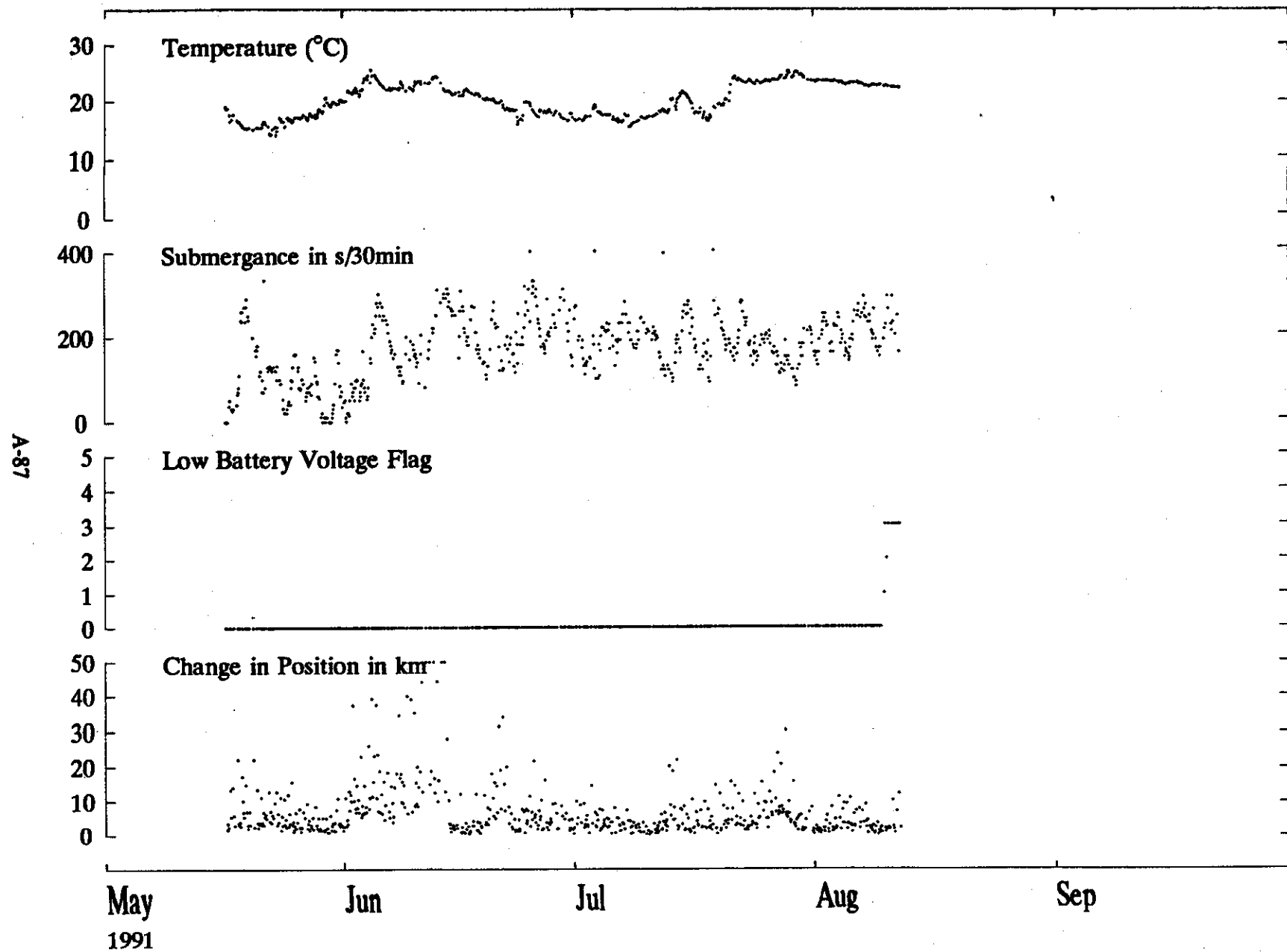


Figure A-29(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12731A. The data have been quality-assured, removing transmission errors and wild points.

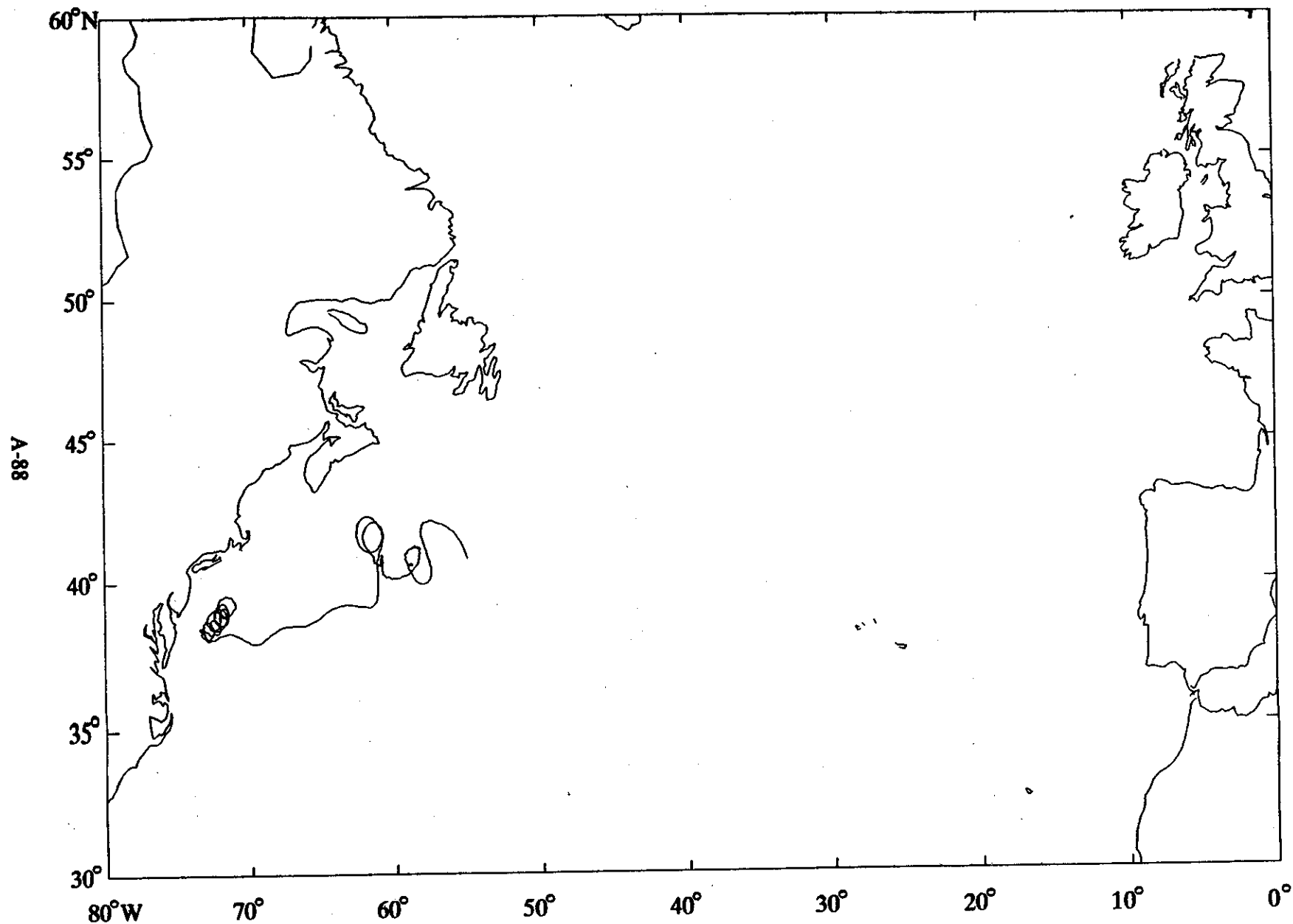


Figure A-30(a). Trajectory of drifter number 12732A deployed on April 21, 1991.
Last transmission received on August 23, 1991.

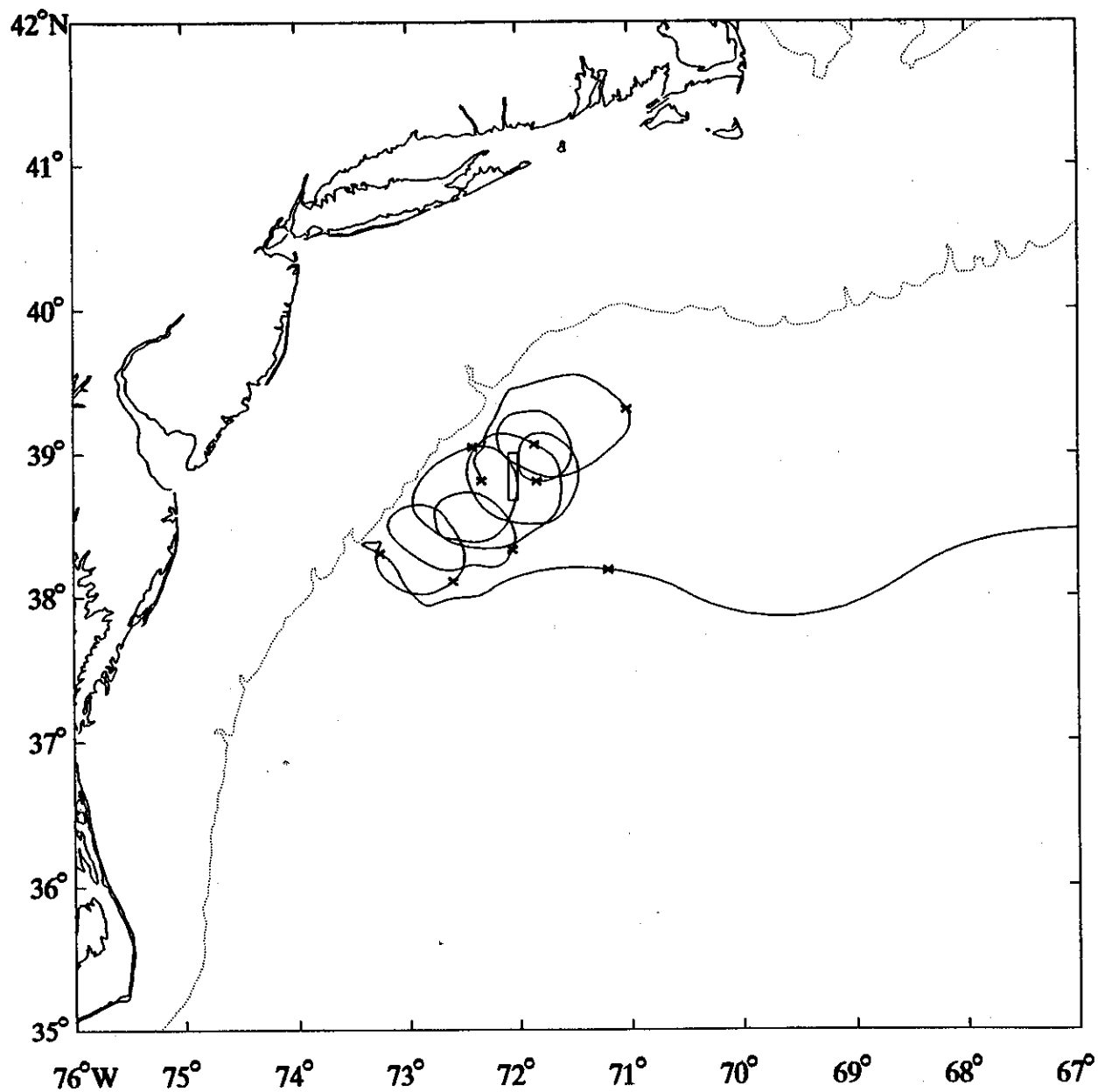


Figure A-30(b). Trajectory of drifter number 12732A deployed on April 21, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

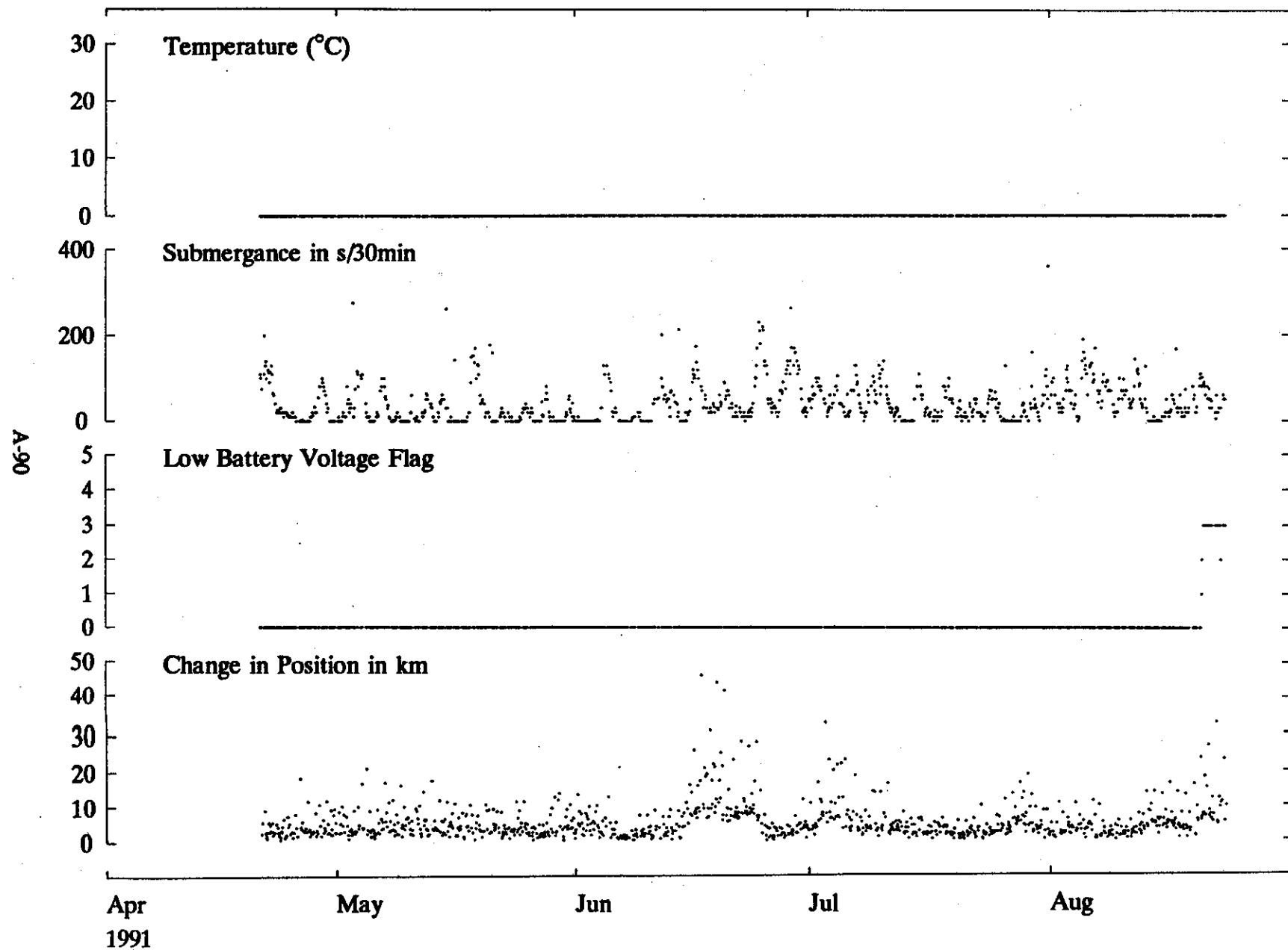


Figure A-30(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12732A. The data have been quality-assured, removing transmission errors and wild points.

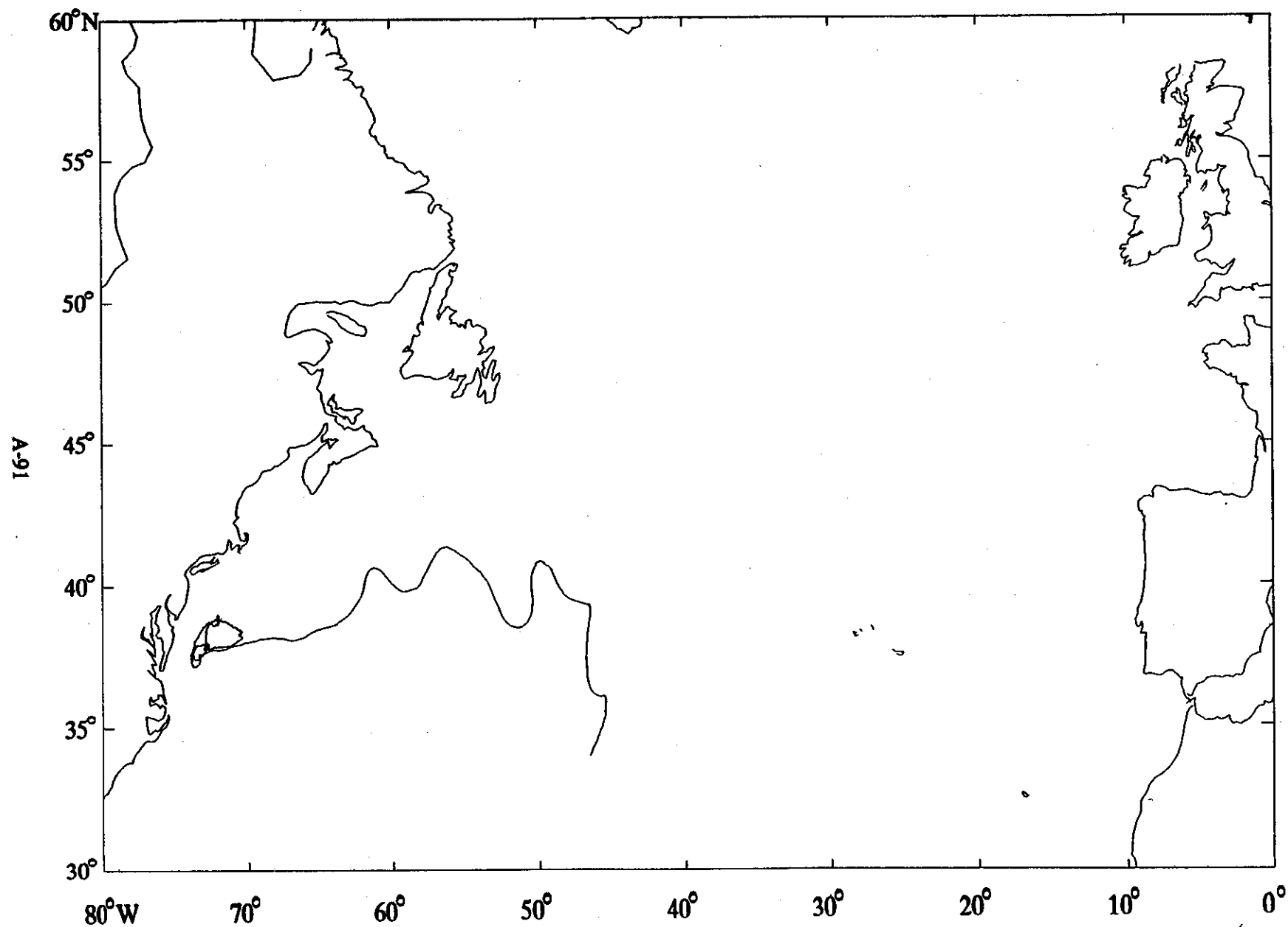


Figure A-31(a). Trajectory of drifter number 12733A deployed on April 27, 1991.
Last transmission received on August 30, 1991.

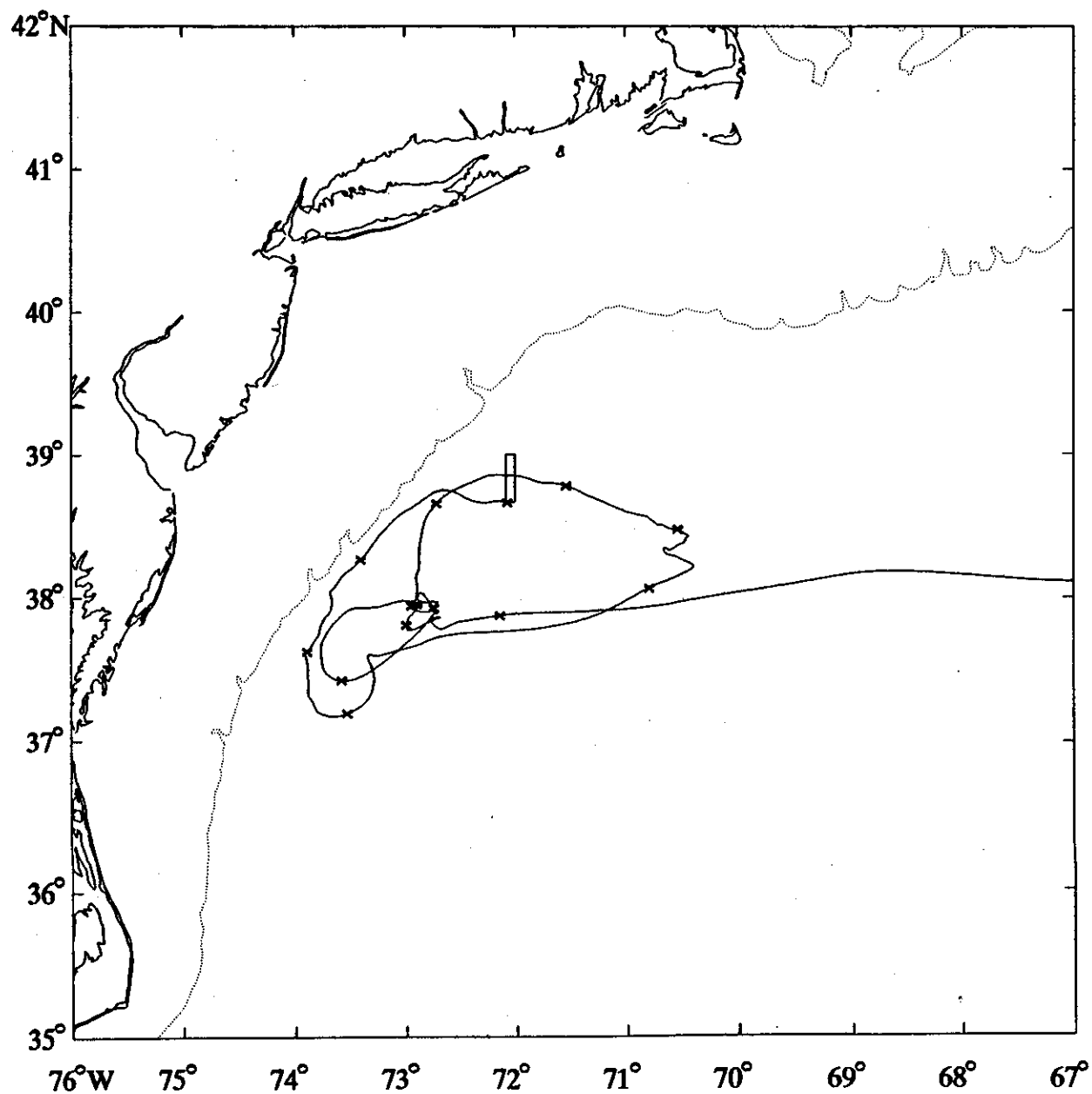


Figure A-31(b). Trajectory of drifter number 12733A deployed on April 27, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

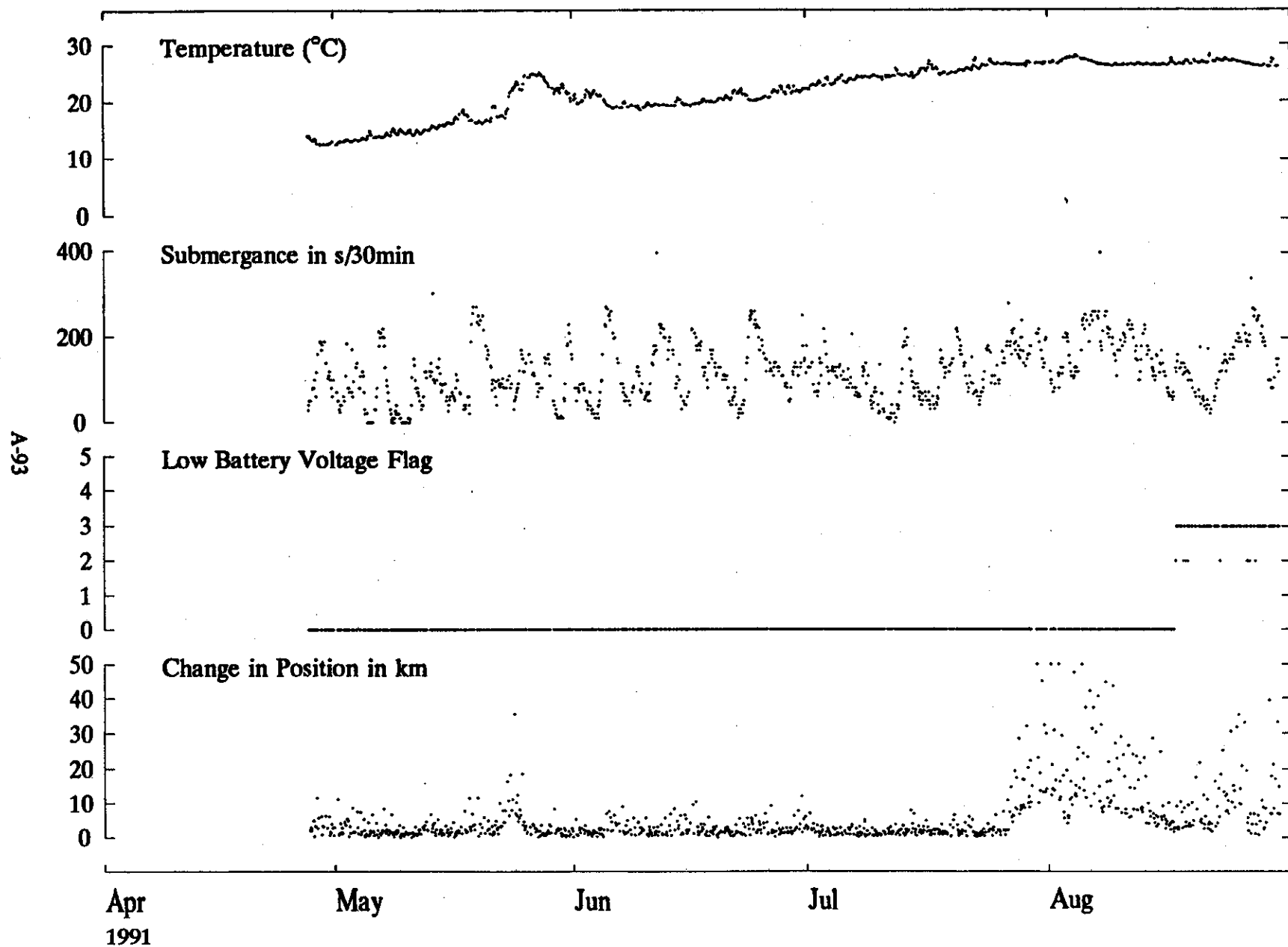


Figure A-31(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12733A. The data have been quality-assured, removing transmission errors and wild points.

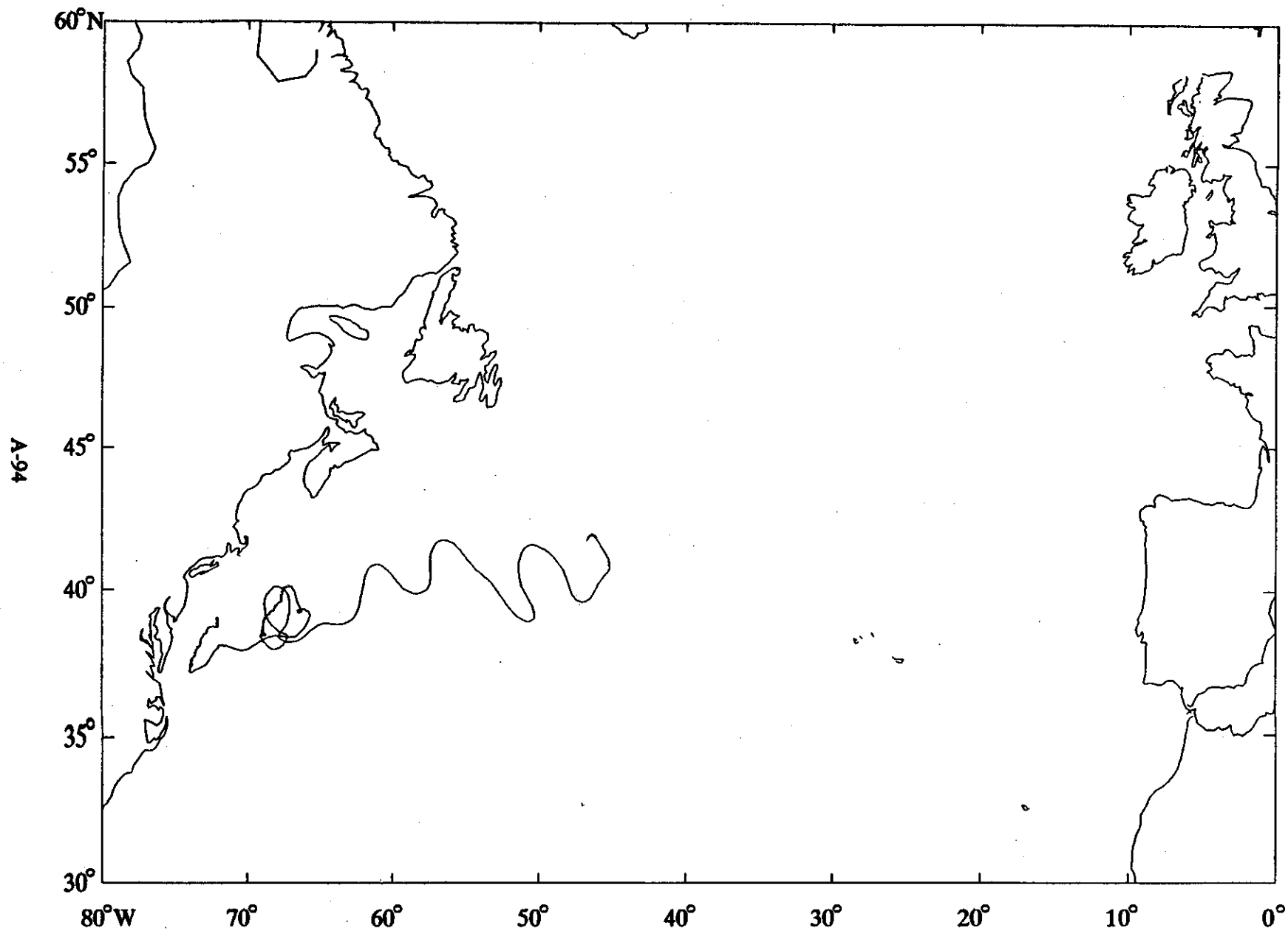


Figure A-32(a). Trajectory of drifter number 12734A deployed on May 3, 1991.
Last transmission received on September 5, 1991.

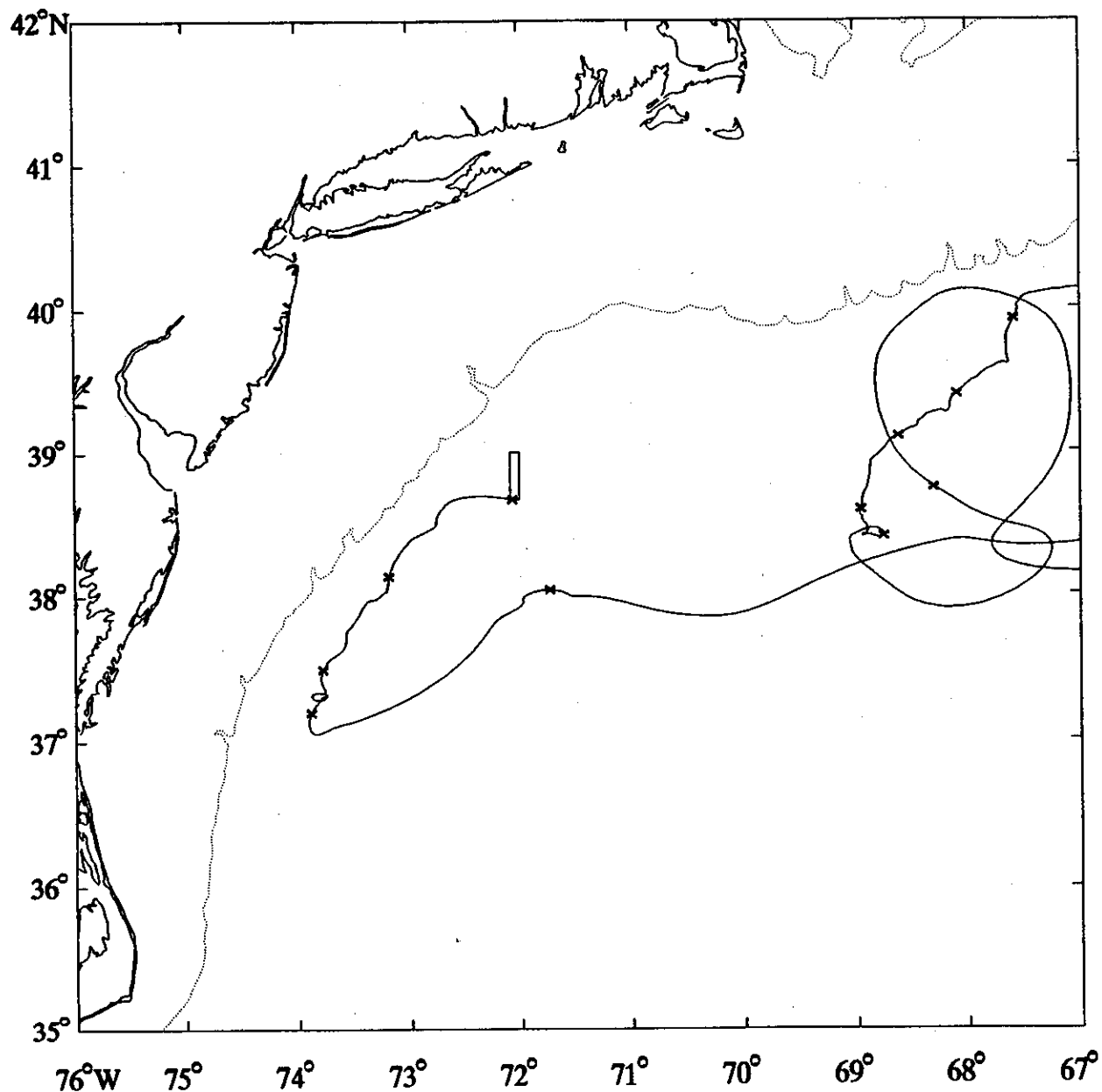


Figure A-32(h). Trajectory of drifter number 12734A deployed on May 3, 1991, shown in the vicinity of the Mid-Atlantic Bight. The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

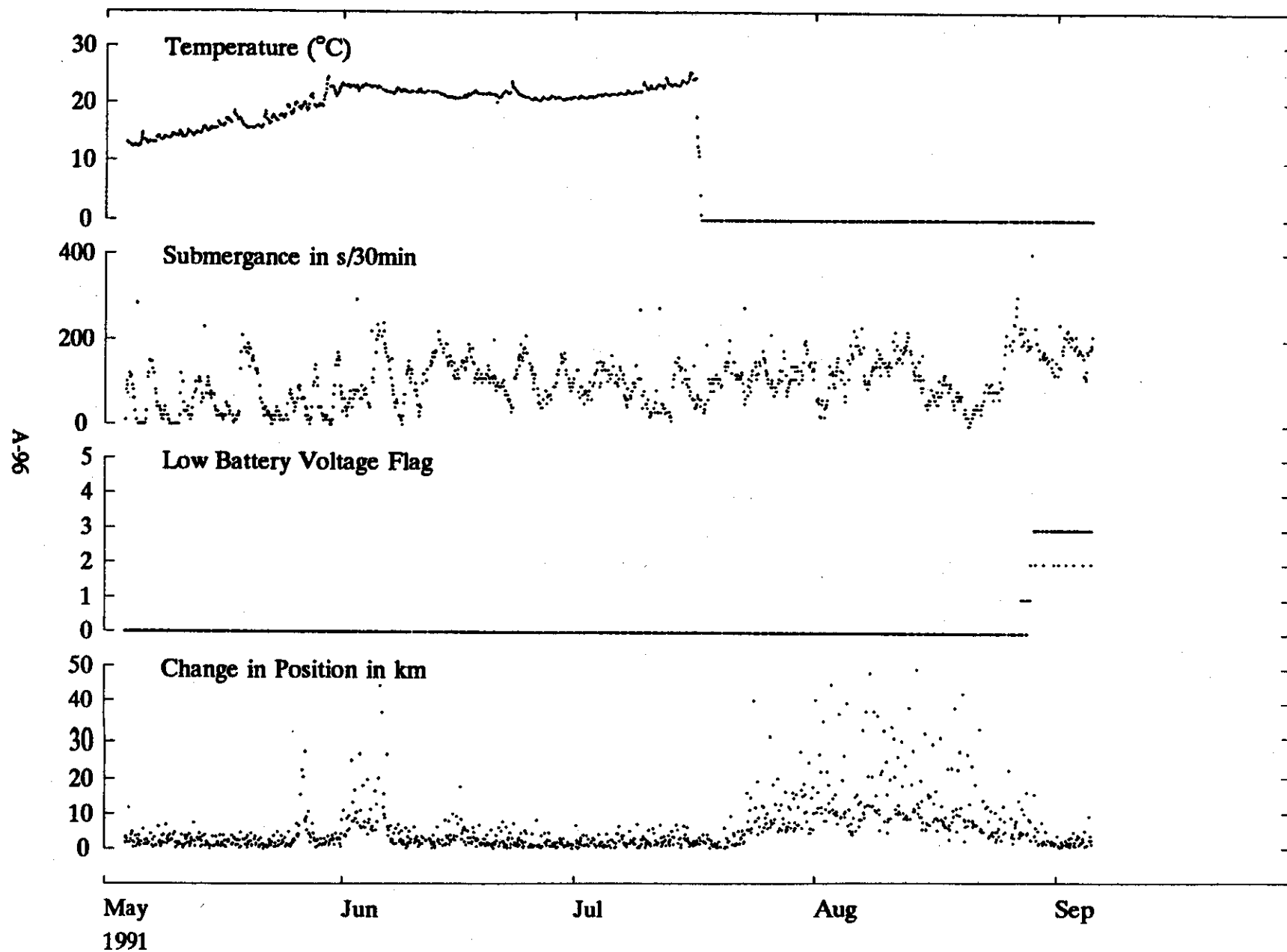


Figure A-32(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12734A. The data have been quality-assured, removing transmission errors and wild points.

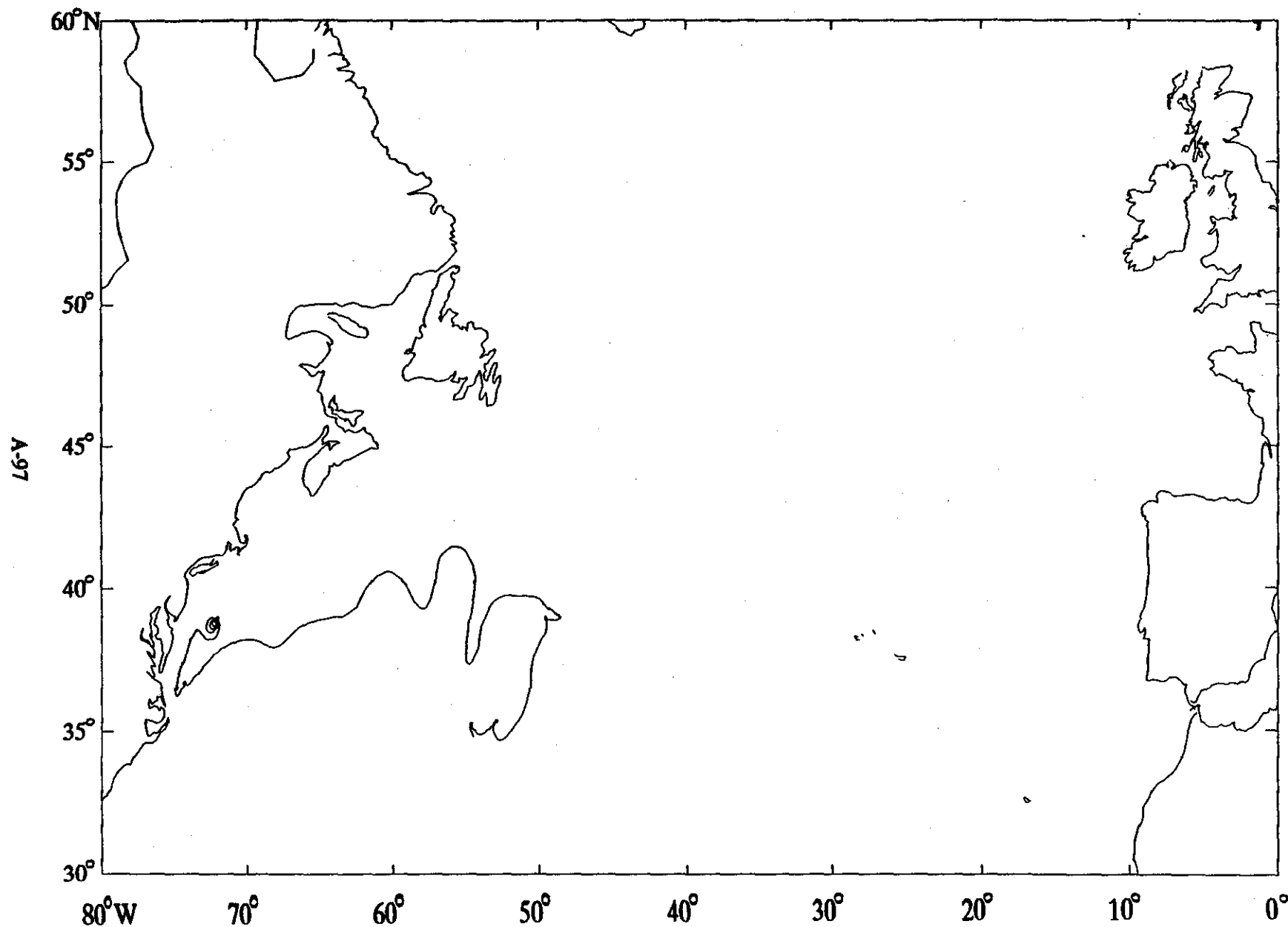


Figure A-33(a). Trajectory of drifter number 12735A deployed on May 11, 1991.
Last transmission received on September 13, 1991.

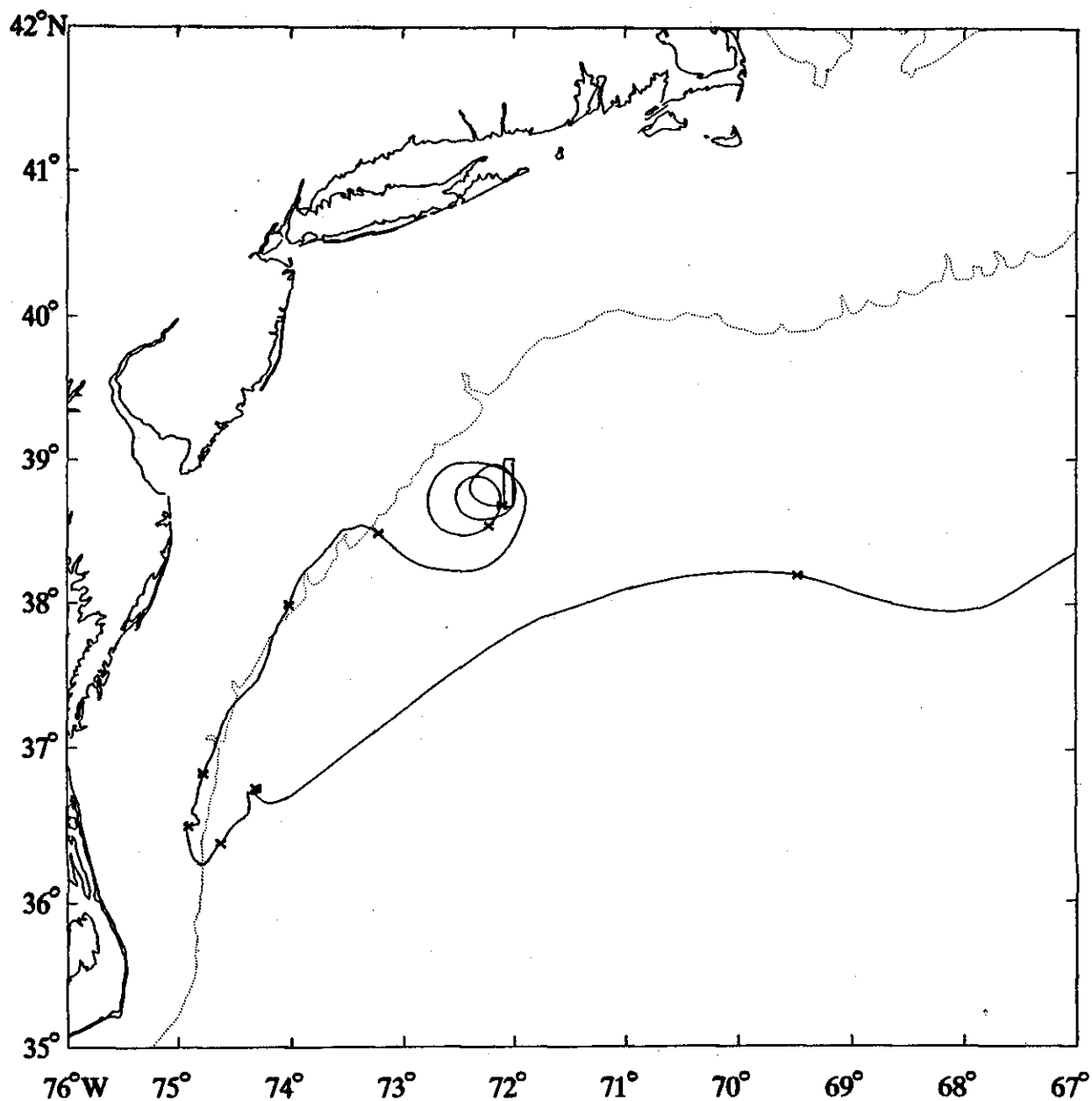


Figure A-33(b). Trajectory of drifter number 12735A deployed on May 11, 1991, shown in the vicinity of the Mid-Atlantic Bight.
The 106-Mile Site is indicated by the rectangle near the center of the figure.
Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

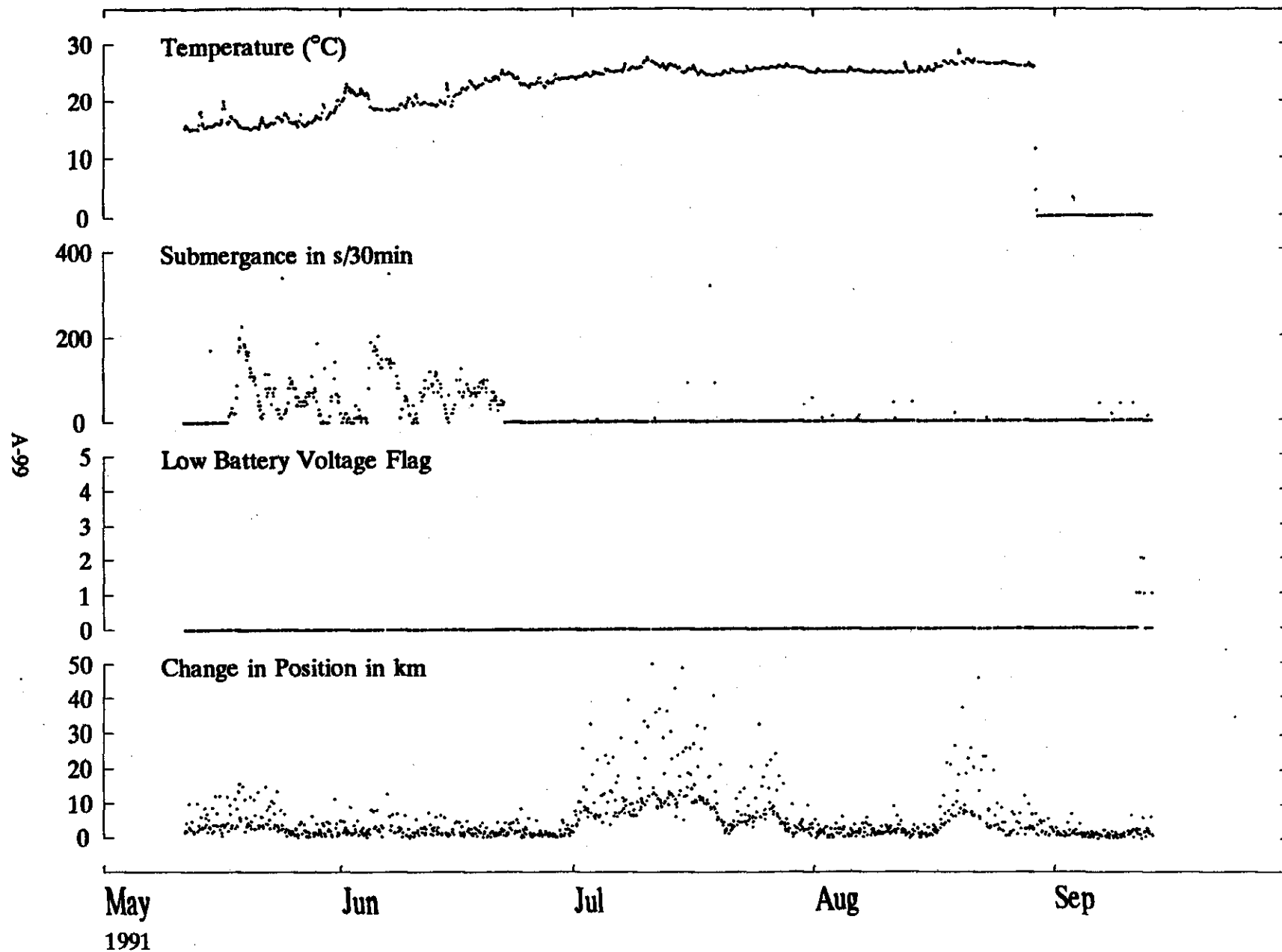
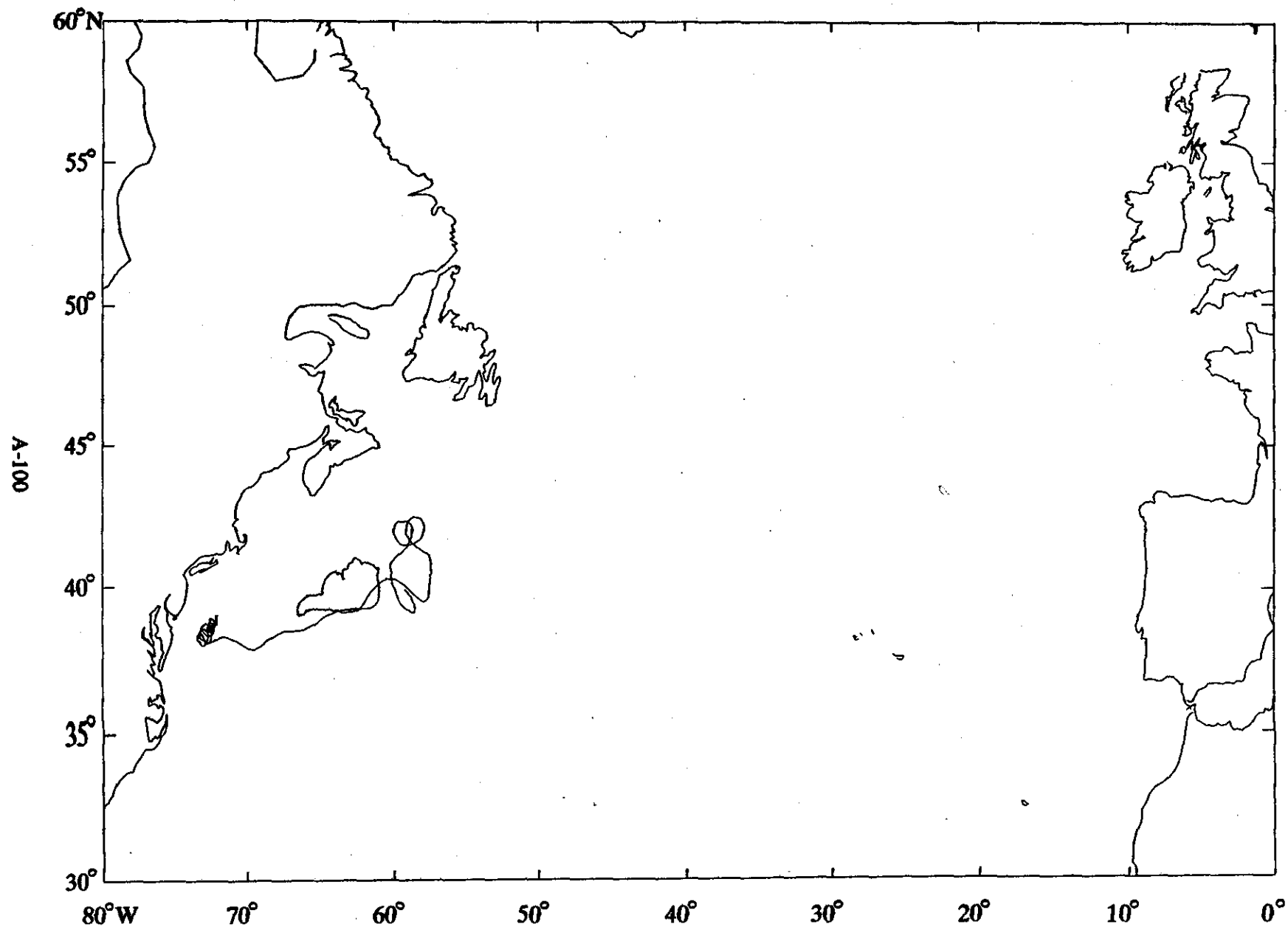


Figure A-33(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12735A. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-34(a). Trajectory of drifter number 12736A deployed on May 16, 1991.
Last transmission received on September 18, 1991.**

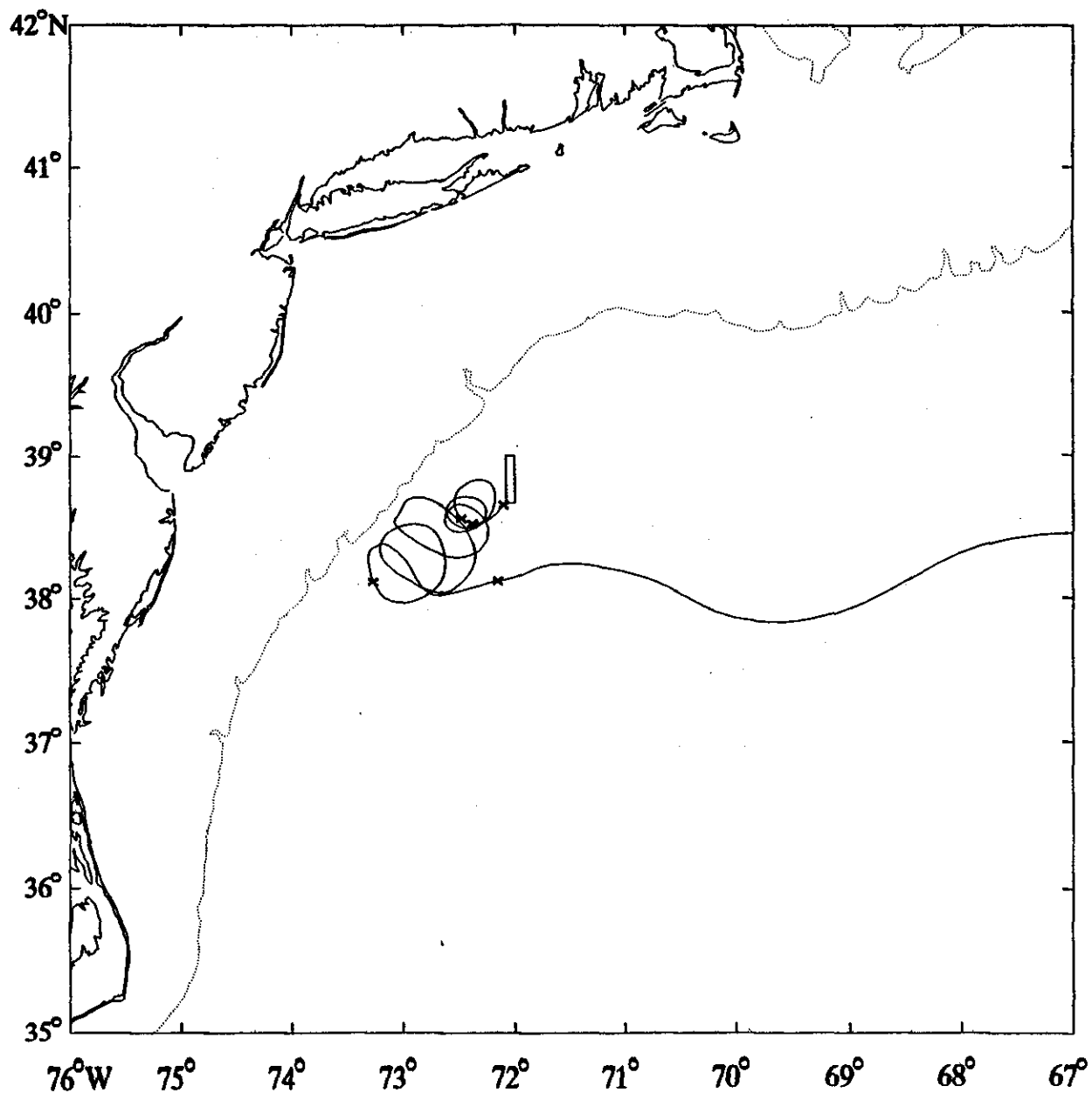


Figure A-34(b). Trajectory of drifter number 12736A deployed on May 16, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.

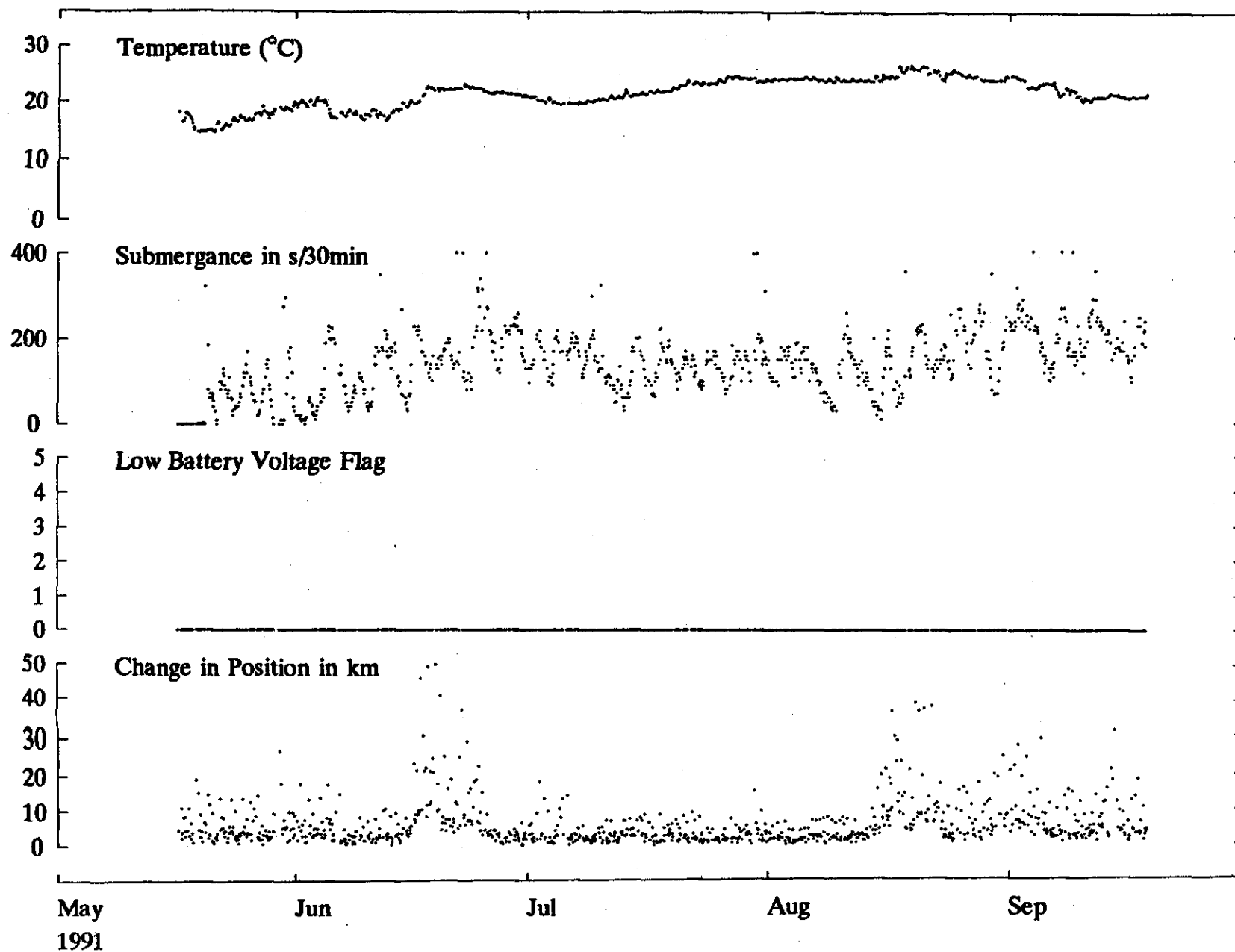
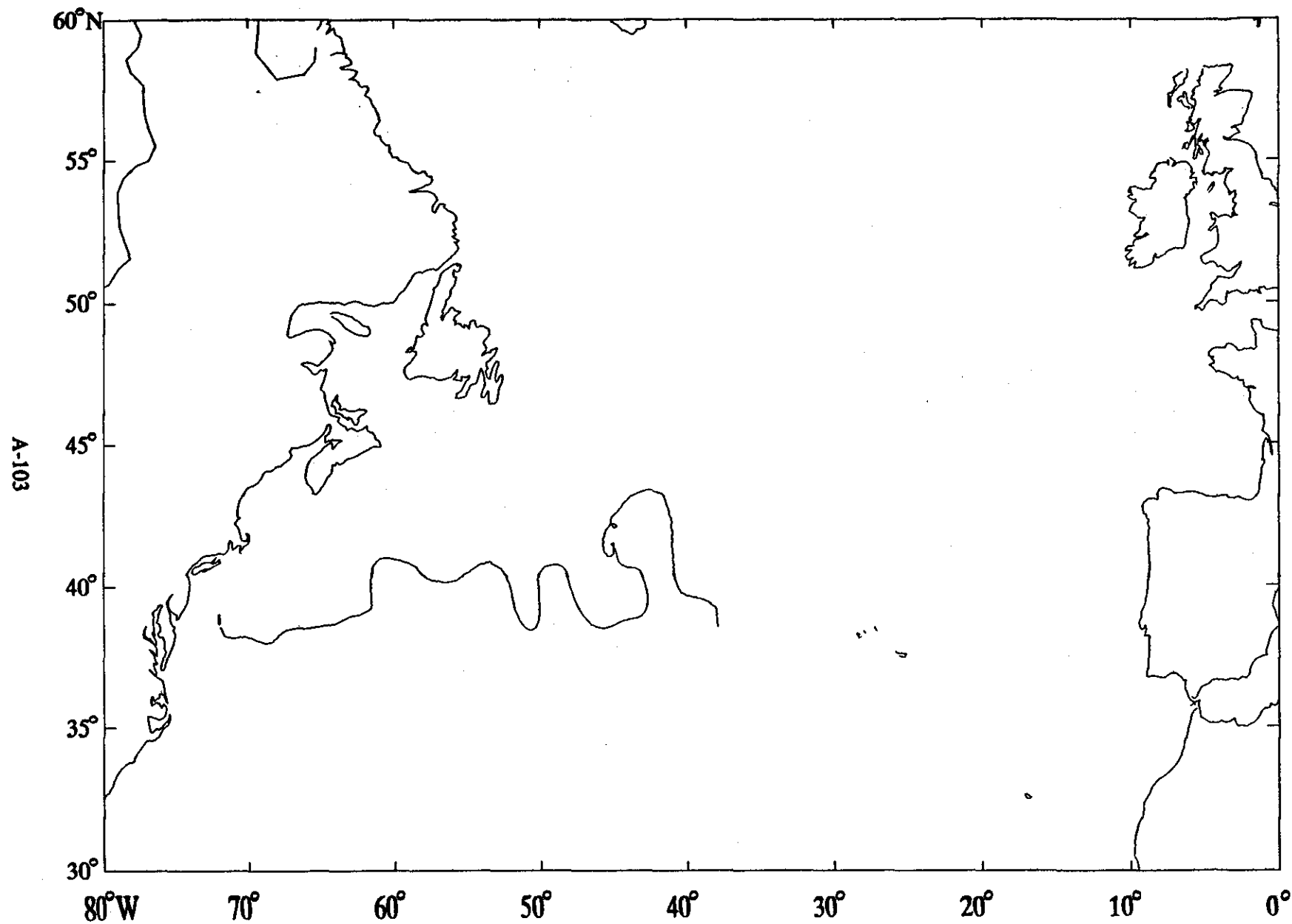


Figure A-34(c). Time series of sea surface temperature, drogue indicator, battery flag, and change in position for drifter number 12736A. The data have been quality-assured, removing transmission errors and wild points.



**Figure A-35(a). Trajectory of drifter number 12737A deployed on May 26, 1991.
Last transmission received on August 25, 1991.**

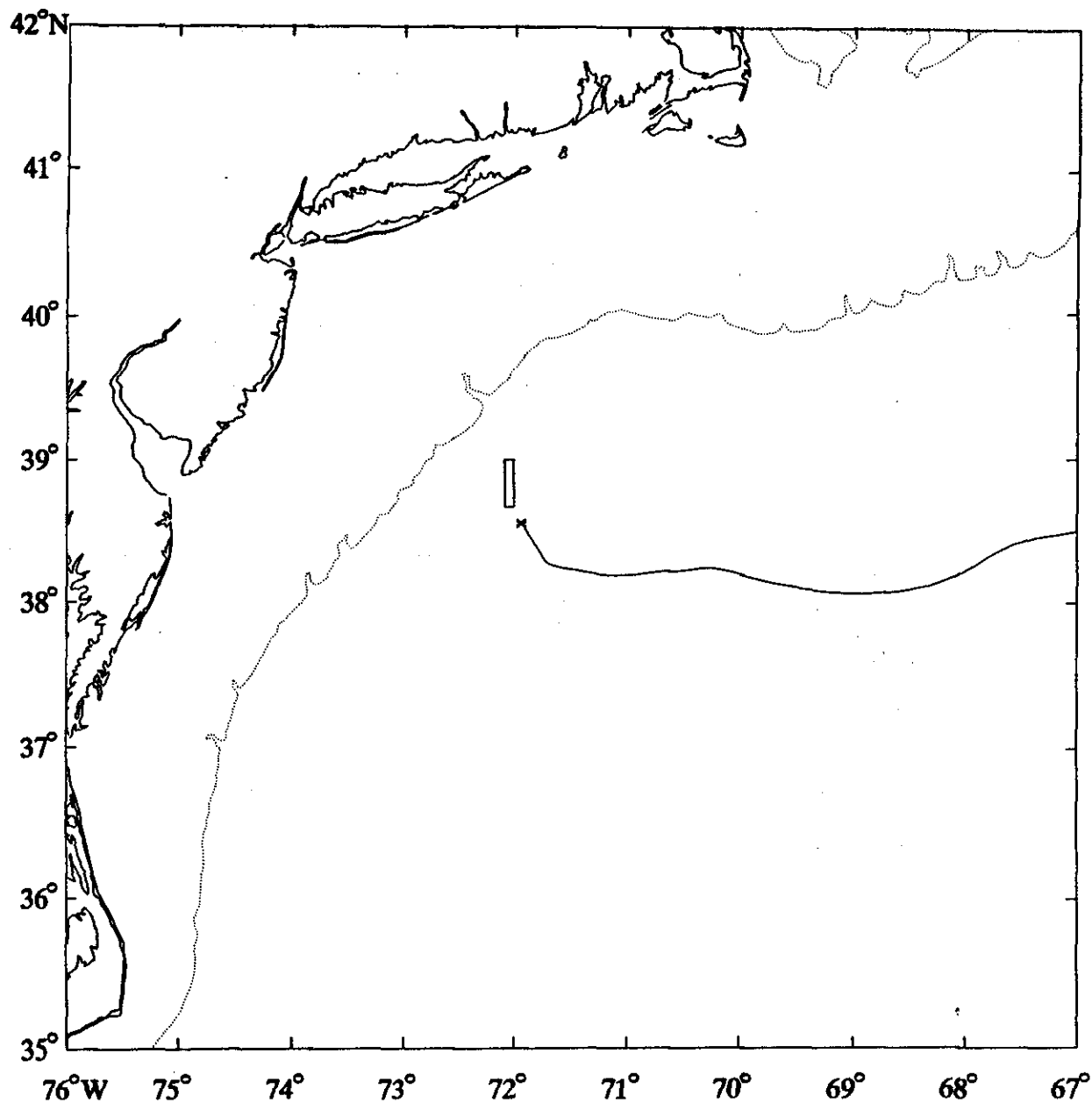


Figure A-35(b). Trajectory of drifter number 12737A deployed on May 26, 1991, shown in the vicinity of the Mid-Atlantic Bight.

The 106-Mile Site is indicated by the rectangle near the center of the figure.

Crosses are spaced at 7-day intervals, and the trajectory has been smoothed with a 2-day low-pass filter.